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THE UNIVERSITY OF ALBERTA

# Issues in the Valuation of Nonmarket Natural Resource Commodities: The Case of Wildlife Resources in Alberta

by

John Asafu-Adjaye

A THESIS

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**Abstract**

The objectives of this research are to contribute to the development of contingent valuation methodology by experimenting with new ways of incorporating elements of uncertainty and nonuse value into nonmarket value measures, and to provide empirical information on economic values associated with wildlife resources in Alberta.

The research objectives are addressed by means of three separate, although interrelated, empirical studies. The issues dealt with are reliability and validity of estimates derived from the contingent valuation survey method, nonmarket valuation under uncertainty and measurement of total economic value. Current approaches for dealing with the problem of error in contingent valuation surveys are critically examined. New methodologies are proposed to elicit values under demand and supply uncertainty. A taxonomy of value measures is proposed, on the basis of which a neoclassical economic model and a framework for measuring total economic value are derived.

The data for this research were obtained from a mail survey of 2,590 Alberta resident hunters. The combined response rate in the three studies was approximately 51%.

The results indicate that current procedures for testing strategic bias, selection bias and the validity of contingent value estimates are not definitive. It is advocated that a more plausible approach to testing the validity and reliability of contingent value estimates would be to derive testable hypotheses based on economic theory. On the subject of uncertainty, it is shown that option price estimates are significantly affected by the level of supply uncertainty, individuals' demand probabilities and their time horizon for use. The total economic value of wildlife resources in Alberta is shown to be substantial. A significant proportion of this value is attributed to nonuse benefits.

Areas identified for future research pertain to the reliability and validity of the contingent valuation method. These include improved modeling of individual behavior and measurement techniques. It is argued that experimental economics could offer a cost-effective and practical means of pursuing the above research agenda.

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# I. Introduction

## A. Background

In many public decision-making processes, values (whether explicit or implicit) have played instrumental roles in determining how resources should be allocated. In recent years, an increasing number of such decisions have been based on the concept of Benefit-Cost Analysis (BCA) in which the social benefits of a proposed policy or program are compared to the social costs in order to determine the net gain to society[1]. A critical factor in this approach is the ability to determine accurate values for the resources involved in the decision problem. The usual practice has been to use market price as a proxy for a given commodity's value. However, environmental resources such as air quality, water quality, recreational use of fish and wildlife and certain unique natural environments present a valuation problem in that they are not traded in competitive markets, and as such their values are not reflected by market prices. This difficulty has often resulted in a tendency on the part of public decision-makers to implicitly assign zero or low values to nonmarket environmental resources in the analysis of public projects.

The valuation of nonmarket environmental commodities has policy relevance insofar as its omission could result in choices which pose long-run detrimental implications for the environment and social welfare. For example, a proposed resource extraction activity (say, open-pit mining of coal) might adversely modify the environment in the form of changes in the ecosystem or elimination of a given species' habitat[2]. A proposed hydro-electric project might affect recreational fishing or a unique natural environment such as a pristine mountain stream; and a proposed expansion of the agricultural land base might lead to a decline in the

---

[1] The normative basis of benefit-cost analysis is the potential Pareto-improvement (PPI) criterion. This criterion is achieved if a proposed program passes a hypothetical compensation test (Kaldor 1939, Hicks 1939). According to this test, the gainers must be able to compensate the losers and still incur a net gain.

[2] Artificial restoration has often been presented as a solution to the effects of this kind of resource extraction. However, as Krutilla and Fisher (1985) point out, the demand for authenticity of a natural environment rules out this option in certain situations.

quality of wildlife habitat, causing a decline in the benefits derived from recreational hunting. Ethical arguments pertaining to our obligations to unborn generations have been made for including the value of such commodities in public choice decisions. Ciriacy-Wantrup (1952) has advocated the idea of a "safe-minimum standard for conservation" as essential for natural resource policy. Page (1977) has argued that preserving opportunities for future generations is a "common sense minimal notion of intergenerational justice".

Much progress has been made in recent years in the valuation of nonmarket commodities since the pioneering work of Hotelling (1947), Ciriacy-Wantrup (1952), Clawson (1959) and Davis (1963). Previous efforts at valuation, especially with regard to outdoor recreation, were based on market prices. Some examples of this approach are the Gross Expenditures Method, the Cost Method, and the Market Value Method (eg., see Knetsch and Davis 1966). In general, these methods have been found to be unsatisfactory because they rely on market prices as indicators of value. Three major approaches have recently been developed to rectify the shortcomings of the above mentioned methods. These are: the Contingent Valuation Method (CVM), the Travel Cost Method (TCM) and the Hedonic Price Method (HPM). The CVM is referred to as the direct method, while the TCM and the HPM are termed "related-market approaches" or "inferential (indirect) approaches" because they are based on the linkages between unpriced natural resources and markets for related goods and services[3].

TCM uses observed trip expenditures as a proxy for market prices (see Knetsch 1963; Burt and Brewer 1971 and Cicchetti et al. 1976) and, in general, is only capable of measuring direct use benefits (eg., for recreation). Recent extensions of the TCM, for example, the Hedonic Travel Cost Model (Brown and Mendelsohn 1984) and discrete choice modeling (Caulkins et al. 1986), allow site characteristics to be incorporated and therefore enable indirect benefits such as aesthetic quality to be measured. The HPM, formalized by Rosen (1974), is based on an approach which incorporates (or bundles) nonmarket goods into the

[3] These two methods are also referred to as weak complementarity approaches because they assume weak complementarity between the market good and the nonmarket good (see Maler 1974).

price of a market good (eg., see Freeman 1979; McConnell 1979; and Bockstael and McConnell 1983). To the extent that such nonmarket values may also reflect potential uses, the HPM is capable of measuring indirect benefits (eg., aesthetic benefits).

The Contingent Valuation Method (CVM) utilizes interviews or mail surveys to ask people about the values they would place on the commodity in question contingent on the existence of a market or other means of payment. To reveal "willingness-to-pay" (WTP), respondents are asked to indicate the dollar amount they are willing to pay to engage in the activity. They are also asked to indicate the dollar amount they must receive in order not to engage in the activity to reveal "willingness-to-accept-compensation" (WTAC)[4]. Various techniques are employed to elicit these responses.

Some examples are (i) direct question methods, variants of which are open-ended (Davis 1963, Hammack and Brown 1974), close-ended (Phillips et al. 1978) and dichotomous choice questions (Bishop and Herbelein 1979); (ii) bidding game methods (Brookshire et al. 1981); (iii) payment-card methods (Mitchell and Carson 1981) and, (iv) contingent ranking (Desvousges et al. 1983). Contingent ranking is a relatively new approach in which respondents are asked to rank the alternatives from most preferred to least preferred. Values are then inferred through statistical analysis of the rankings. In contrast to the TCM and HPM, the CVM can be used to value direct and indirect benefits, as well as nonuse benefits. Thus, it is clearly the most flexible nonmarket valuation technique in that it can be applied to a wider range of valuation problems.

In spite of the significant advances which have been made in developing techniques for estimating nonmarket values, much remains to be accomplished in terms of tackling pervasive issues which impinge on the valuation problem. One such issue is the effect of uncertainty on value measures. Early contributors to the literature on resource valuation

[4] Various CV studies (eg. Bishop and Heberlein 1979; Knetsch and Sinden 1984; Adamowicz and Phillips 1983) have found WTAC to be substantially greater than WTP when theory suggests they are equivalent measures, give or take small differences due to income effects. Tversky and Kahneman (1987) have rationalized these observations in terms of loss aversion, i.e. the response to losses is more extreme than the response to gains. See also, Haneman (1986) for a different perspective of the discrepancy between WTP and WTAC.

recognised the importance of uncertainty (see, for example, Eckstein 1958) but chose to attack the problem via the discount rate. The need to give explicit attention to uncertainty in the analysis of public projects can be attributed to Weisbrod (1964) who noted that there might be some people who, although not current users, might nevertheless place a significant value on the option of consuming the resource in future. He referred to this as option value.

There are two major sources of uncertainty - uncertainty about future demand and uncertainty about future supply. Demand uncertainty could arise from price, income or preference (for example, taste) uncertainty. Supply uncertainty could arise from either uncertainty about future physical availability or quality (for example, uncertainty about whether a specific bird would be sighted on a given bird-watching trip). Due to lack of a consistent theoretical framework and a feasible empirical methodology, past efforts at nonmarket valuation have been predicated on an assumption of perfect certainty or knowledge on the part of the analyst. Assuming a riskless world, economists have chosen the appropriate measure of value of a given commodity to be aggregate willingness-to-pay (or consumers' surplus) associated with its use[5]. Such an assumption is implicit in the econometric practice of treating regression parameters as known with certainty and subsuming effects due to chance in the disturbance term. Unfortunately, the assumption of perfect certainty is unrealistic in the real world.

It has been shown that in addition to uncertainty, there may be nonuse values (not necessarily related to uncertainty) associated with natural resources. Examples are ***existence value*** and ***bequest value***. The former arises from a desire to have environmental resource services continue to exist regardless of use or option value, while the latter arises from the desire of consumers to pass on a relatively unspoiled environment to future generations. It has been suggested (Krutilla 1967; Krutilla et al. 1972) that in cases involving natural resource commodities, these values are likely to be significant. While empirical studies of nonuse values are limited, those that have been reported show varying degrees of significance depending on the type of commodity. Research by Walsh et al. (1984) on water quality indicates that

[5] The terms "risk" and "uncertainty" will be used interchangeably outside of Knight's (1921) definitions.

existence value is greater than use value. Existence value is also shown to be substantially greater in work by Schulze et al. (1983) on air quality. However, other studies on water quality summarized in Fisher and Raucher (1984) report nonuse values to be some fraction of actual use value. It is significant to note that in all the reported cases, existence values are positive implying that failure to include them could result in undervaluation of total benefits[6].

**B. Research Objectives**

In view of the gaps in knowledge outlined in the foregoing discussion, this research aims at achieving the following objectives:

1. It seeks to contribute to the development of contingent valuation methodology by experimenting with new ways of incorporating elements of uncertainty and nonuse into nonmarket value measures.
2. In pursuing the above objectives, the research will enhance empirical knowledge in regard to economic values associated with wildlife resources in Alberta.

**C. Organisation of Research**

The foregoing introductory section has touched on the historical development of the contingent valuation method. In attempting to contribute to further development of CV methodology, this research focuses on the contemporary issues of bias, uncertainty and nonuse values. In this regard, the research is organised as a series of three separate, although interrelated, empirical studies.

A major reason for skepticism about the reliability and validity of the CVM is the bias associated with the approach (eg., see Cummings et al. 1986). The general belief implied in parts of the literature is that 'true' values exist for a given public good. In this respect, the role of the CVM is seen as the 'discovery' or 'revelation' of such values. To the extent that

[6] It is entirely plausible that the marginal utility of certain natural resources for particular individuals could be negative, thus giving rise to negative existence values.

reported values may deviate from the 'true' values, the CVM is thought to yield 'biased' or 'incorrect' estimates. This line of reasoning has been challenged (eg., see Mitchell and Carson 1989; Thayer 1981). The first empirical study of this research (chapter II) addresses the issue of bias in contingent valuation surveys. Potential sources of bias or error in a typical CV application are reviewed. An effort is made to distinguish between bias and legitimate effects arising from CV surveys. To obtain a better understanding of the data, tests are devised to check the reliability and validity of the estimates. Other tests and data handling procedures which have recently been suggested in the literature are critically reviewed.

The second study chapter (chapter III) addresses the issue of nonmarket valuation under uncertainty. The issue of uncertainty is widely believed to be relevant to the valuation of nonmarket environmental commodities. However, there is a dearth of empirical research on the subject. Previous researchers (eg., Greenley et al. 1981; Walsh et al. 1984) have approached the problem by attempting to elicit option value directly by means of CVM. There are two problems with this approach. First, the theoretical basis of measuring option value in such a manner has not been justified[7]. Second, it is doubtful whether option value, being the difference between option price and expected consumer's surplus, can accurately be elicited from the consumer in this fashion. Others (eg., Schmalensee 1975) have suggested using expected consumer's surplus as a measure of benefits given uncertainty. However, this too is problematic. Recent theoretical developments clearly show that expected consumer's surplus may not give maximum benefits. Thus, there is the risk of underestimating aggregate benefits using this approach.

In the first part of chapter III, a new CV design is presented which enables nonmarket value estimates to be obtained when there is demand uncertainty. The merits of alternative benefit measures obtained by this approach are discussed. The second part of the chapter deals with the issue of supply uncertainty. This subject has also been virtually untouched in applied work. It would seem to be relevant in various facets of environmental resource use. In the recreational use of wildlife, for example, certain species (eg., grizzly bear) are faced with

[7] In other words, the methodology used in these studies is not derived within the framework of the utility-maximizing consumer.

actual prospects of drastic reductions in numbers and quality of habitat. This part of the study examines the effects of supply uncertainty and socioeconomic variables on the magnitude of option price. Expected Utility (EU) theory has long been a popular model in economics, but has recently been criticised as being an inadequate representation of consumer behavior (eg., see Shoemaker 1982). In this chapter, tests are derived to ascertain whether consumers behave according to the postulates of EU theory. The value estimates obtained in the study are shown to be consistent with the predictions of the theory.

The final empirical study (chapter IV) addresses the issue of total economic value, in the context of the recreational use of wildlife resources in Alberta. A major obstacle to empirical advancement in this area is the lack of a concensus among economists as to what constitutes value, especially nonuse value. In this chapter, a comprehensive taxonomy of value measures is compiled. An attempt is made to reconcile apparent differences in terminologies applied in previous studies. A neoclassical model which is consistent with this taxonomy is then introduced. The empirical results show that nonuse values form a fairly significant portion of total value, thus giving justification to the belief that their omission could result in an underestimation of social benefits.

The concluding chapter of the study consists of a general discussion of the various aspects of the research. This includes a summary of the major findings, a discussion of the implications of the research and directions for future research.

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## II. Tests of Bias in a Contingent Market for Recreational Hunting

### A. Introduction

The Contingent Valuation Method (CVM) was first applied by Davis (1963a; 1963b) in a study to estimate the value of big game hunting in the Maine Woods. The method seeks to solve the nonmarket valuation problem by presenting individuals with a hypothetical market, and asking them how much they would be willing to pay for increments or decrements in the level of a given natural resource/environmental commodity (Brookshire et al. 1980). The basic assumption in this approach is that individuals are capable of responding to questions so as to reveal their true preferences for a given commodity. The advantages of the CVM are well documented (see, for example, Brookshire and Crocker 1981; Brookshire et al. 1976). In recent years, there have been indications that the method has achieved a reasonable level of 'acceptability' for policy making purposes[1]. In spite of these advances, considerable skepticism remains about the efficacy of the CVM as a means of generating reliable estimates of value for nonmarket environmental commodities.

The major sources of doubt about the CVM pertain to the hypothetical nature of the approach and the "public goods" characteristics of the commodities it is used to value. The former raises concerns about the validity of CV responses while the latter is thought to induce strategic behavior. According to the "Strategic Behavior Hypothesis", it is "in the interest of each person to give false signals to pretend to have less interest in a given collective consumption activity than he really has." (Samuelson 1954, p.389). To date, empirical evidence on strategic bias appears to indicate that the extent of the problem has sometimes been overstated. In several laboratory studies, researchers have attempted to get people to behave strategically, yet such behavior has been rare (Bohm 1972; Smith 1977; Marwell and Ames 1979, 1980, 1981; Alfano and Marwell 1981; Tideman 1983; Isaac et al. 1984; Kim and

[1] In 1979, the U.S. Water Resources Council specifically authorized the use of CVM for analyzing environmental quality problems (U.S. Water Resources Council 1979, 1983). The CVM has now been adopted by the U.S. Government as a tool for assessing natural resource damages (U.S. Department of the Interior 1986).

Walker 1984; Brubaker 1982). Attempts to find evidence of strategic behavior in CVM studies have proven unsuccessful (Thayer 1981; Schulze et al. 1981; Bishop and Heberlein 1979, Bishop et al. 1988). Smith (1980) found that in experimental public goods markets with relatively weak incentives for preference revelation, most respondents accurately report their personal valuations. He concludes, "if everyone always acts strategically, it is hard to explain the prevalence of flourishing churches" (Smith 1980, p.584).

To establish the validity of the CVM, studies have been reported in which value estimates obtained from the CVM compare favorably with results from other methods. Examples are: the Travel Cost Method (Desvousges et al. 1983; Sellar et al. 1985; Knetsch and Davis 1966); the Hedonic Price Method (Brookshire et al. 1982; Smith et al. 1986); simulated markets (Bishop et al. 1988; Bohm 1984); and actual markets (Dickie et al. 1987). On the other hand, other studies have found significant discrepancies between values obtained from simulated and hypothetical markets (Bishop et al. 1983; Kealy et al. 1988). Evidence of starting point bias has been found in CVM applications using bidding game formats (Rowe et al. 1980; Desvousges et al. 1983; Mitchell and Carson 1981). Finally, some studies have found that CV estimates are affected by the amount of information disclosed (Samples et al. 1986; Stoll and Johnson 1987; Stephenson and Taylor 1988).

The validity of a measure (or method) can be defined as the degree to which it measures a given concept. In many applications of the CVM, the concept under consideration (i.e., nonmarket value) is not directly observable[9]. Therefore, tests in which CVM values are compared with those of another method (eg., TCM) are not definitive. Since values from both methods cannot be validated against a 'true' value, evidence of correlation between CVM and TCM values does not necessarily prove the validity of one or both methods[10].

Given the increasing use of the CVM for policy purposes, particularly for the analyses of a broad range of environmental and natural resource problems, there is a need for

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[9] An exception is where a parallel market (eg., simulated market for hunting permits) can be established for the good in question.

[10] Such "comparison tests" have been defined elsewhere as tests of "convergent validity" (eg., see Mitchell and Carson 1989).

continuing efforts to develop tests of the validity and reliability of CV responses. One approach is to ascertain that benefit estimates derived from the CVM accord with the predictions of economic theory[11]. This study addresses the problem of error in CV surveys. Potential sources of error in CV surveys are reviewed. Tests are devised to investigate the reliability and validity of estimates derived from a CV survey of recreational hunting in Alberta. Other data handling procedures which have been suggested in the recent literature are critically reviewed. The remainder of the study is organised as follows: section B discusses the potential sources of error in CV applications. Section C outlines the tests of hypotheses to be carried out, while section D discusses the experimental design. The test results and discussion are presented in section E. Finally, the summary and implications are presented in section F.

**B. Potential Sources of Error in CVM Applications**

In traditional measurement theory, error is defined as a deviation between an observed value and an underlying 'true' value which is usually unobserved (eg., see Bohrnstedt 1983). In the context of the CVM, the former can be represented as an individual's reported willingness-to-pay for a given nonmarket good, and the latter as his or her true or actual willingness-to-pay. The deviation, or bias, between the two values can be attributed to two major sources: *random error* and *systematic error*. Random error, also referred to as "pure noise", occurs from the process of selecting a suitable sample size and survey design, and from eliciting responses from the individual. The extent of random error is reflected by the magnitude of the standard error of the mean reported value. Systematic error exists to the extent that there is a nonzero difference between the expected values of reported willingness-to-pay and true (actual) willingness-to-pay. In CVM applications, the issue of reliability is related to random error while that of validity is related to systematic error[12].

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[11] Recently, progress in this area has been achieved by means of revealed preference methods. See for example, Varian (1982), Richter (1979), and Adamowicz and Graham-Tomasi (1988).

[12] When people talk about 'bias' in the CVM, they are actually referring to systematic error.

The view in the traditional CV literature had been that the hypothetical nature of the CVM gave rise to biased responses. For example, Rowe et al. defined "hypothetical bias" as "the potential error induced by not confronting any individual with the real situation" (Rowe et al. 1980, p.6). Under the rubrics of hypothetical bias were identified various types of bias such as information bias, payment vehicle bias, framing bias, etc. However, the fact of the matter is that in the case of nonmarket commodities, true values may never be ascertained. Individuals' reported values may be conditioned on the characteristics of the contingent market scenario. Thus, differential results obtained by varying the amount of information, the payment vehicle or method of provision must not be taken as evidence of bias. Rather, such so-called "biases" must be viewed as legitimate effects obtained from varying the parameters of the contingent market. Such effects fall under the above definition of random error and do not pose serious threats to the CVM. With increasing sophistication in the state-of-the-art, they can be mitigated or even eliminated. The challenge to the credibility of the CVM comes from the various types of systematic error which are more difficult to address. We outline below the principal sources of such error.

At least three types of systematic error can be identified in a CV study: strategic bias, sample related error, and errors arising from a misperception of the contingent market scenario. Strategic bias occurs when some respondents make conscious attempts to misrepresent their preferences in the belief that their responses might influence policy[13]. Sample related errors arise from failure to plan and implement an appropriate sampling design. Examples are where a non-probability sampling design is employed (i.e., each member of the population is not given a known and positive probability of being selected), or where the survey population does not match the target population (sampling frame bias)[14]. We focus below on two additional forms of sample related error - sample nonresponse bias and sample selection bias - which are more intractable than the previous two.

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[13] The term "free-riding" is often used where the individual reports a value (eg., $0) lower than what the good is actually worth to him or her.

[14] See Rossi et al. (1983), Sudman (1982) for a good discussion on these types of sampling error.

A potential for nonresponse bias and selection bias exists when certain individuals do not respond to the entire survey (unit nonresponse), or to a particular question(s) (item nonresponse). Nonresponse bias may be distinguished from selection bias in that while the former is a *between group* phenomenom, the latter is a *within group* phenomenom. For example, where a certain identifiable subgroup in the population, say, low income wage earners, are underrepresented compared to upper income groups, nonresponse bias occurs to the extent that the former subgroup may hold lower willingness-to-pay values. In this case, the estimated mean willingness-to-pay will be biased in an upward direction. On the other hand, selection bias occurs to the extent that the low income earners hold different values compared to similar individuals who do not respond[15].

The CVM is more susceptible to this kind of bias because, by its very nature, a typical CV survey (eg., a mail survey) allows respondents an opportunity for self-selection (or censoring). For example, it is very often those individuals with a high degree of concern for the environment who tend to participate in surveys on that subject. Selection bias could also be caused by the analyst through the usual practice of deleting zero bids and outliers. It is important to note from the foregoing discussion that sample selection bias could occur independently of or simultaneously with sample nonresponse bias. Weighting procedures are often used to correct for nonresponse bias due to unit nonresponse, while imputation techniques are available for handling item nonresponse (eg., see Kalton 1983, Dempster et al. 1977, Breiman et al. 1984). However, sample selection bias is not amenable to either weighting or imputation procedures. Procedures are outlined below for testing strategic bias, framing effects and selection bias.

[15] See Mitchell and Carson (1989) for a more detailed exposition on sample nonresponse and selection biases.

## C. Tests of Hypothesis

### Strategic Bias

A test of strategic bias originally proposed by Brookshire et al. 1976 is based on a visual inspection of bid distributions. In this test, it is assumed that the distribution of 'true' bids is normal. Thus, according to this test, the presence of a larger than normal concentration of bids at one or both tails of the distribution is taken as evidence of strategic behavior. Although widely applied in the literature (eg., see Desvousges et al. 1987, Rowe et al. 1980, Schulze et al. 1981, Sutherland and Walsh 1985), the Brookshire et al test can be criticised on a number of grounds. First, the test is predicated on the assumption that true bids are normally distributed whereas the actual distribution of true bids may never be ascertained. Second, CV bids, unlike market prices, pertain to an area under the demand curve (i.e., consumer's surplus). Therefore, there seems to be no *a priori* reason why they should be normally distributed. Third, even if the true value about which a normal distribution could be expected existed, it might be incorrect to presume that the only effect of bias would be to produce a nonnormal or 'flat' curve. It is plausible that the effect of bias would be to shift the distribution to the left or right. Finally, it is shown below that zero or very high bids (outliers) may represent genuine bids. It may thus be concluded that the Brookshire et al. 1976 test of strategic bias is not definitive and may not be valid.

### Framing Effects

Owing to the hypothetical nature of most CVM applications, there is always a risk that the same commodity may be perceived differently by different individuals. We present below a test for ascertaining the extent to which willingness-to-pay responses are affected by the way in which the questions are framed.

**Proposition 1:** Willingness-to-pay (WTP) measures for the same commodity should not be affected by the way in which the WTP question is framed (i.e., described). Thus, the

hypothesis to be tested in this case is:

$$\text{H1:} \quad WTP(Q1) = WTP(Q2) \tag{1}$$

$$\text{H2:} \quad V(1) = V(2) \tag{2}$$

where Q1 and Q2 are different questions designed to elicit the same measure of value for a given commodity, and V(1) and V(2) are their respective variances. Equation (1) tests the relative magnitudes of the estimates, while equation (2) is a test of the precision of the estimates.

**Selection Bias**

In the case of selection bias, a procedure originally developed for the analysis of labor markets (Gronau 1974; Lewis 1974; Heckman 1976, 1979), and recently adopted for the CVM (Edwards and Anderson 1987; Smith and Desvousges 1987) and the TCM (Wilman and Pauls 1987), is examined. In this approach, the problem of selection bias is viewed as an ordinary specification error or "omitted variable" bias. Suppose there is a random sample of N observations and the following two behavioral equations:

$$Y_{1j} = X_{1j}\beta_1 + u_{1j} \quad (j = 1,\ldots n < N) \tag{3}$$

$$Y_{2j} = X_{2j}\beta_2 + u_{2j} \quad (j = 1,\ldots N) \tag{4}$$

where $X_{ij}$ is a N by $K_i$ vector of exogenous variables; $\beta_i$ is a 1 by $K_i$ vector of behavioral parameters; and where the $u_{ij}$ are well-behaved vectors of residuals. The last assumption holds for a random sampling scheme. Since the regressors are assumed to be of full rank, the parameters of each equation could be estimated by OLS given full data on each variable. Suppose the intention is to estimate (3) where $Y_{1j}$ is willingness-to-pay, and where only the first n observations contain data on WTP. The crucial issue is why the data are missing. Let the population regression function for (3) be represented as:

$$E(Y_{1j} | X_{1j}) = X_{1j}\beta_2 + u_{1j} \quad (j = 1,\ldots N). \tag{5}$$

The regression function for the incomplete sample may be written as:

$$E(Y_{1j} | X_{1j}, \text{sample selection rule}) = X_{1j}\beta_1 + E(u_{1j} | \text{sample selection rule}). \tag{6}$$

Based on theory, the following proposition can be put forward:

**Proposition 2:** The existence of selection bias depends on whether or not the error terms $u_{1_j}$ and $u_{2_j}$ are independent. If $u_{1_j}$ is independent of $u_{2_j}$, the conditional mean is zero, and therefore the selected subsample is identical to the population regression function.

It can be shown that, in general, selection into the sample is nonrandom. Suppose that data are available on $Y_{1_j}$, if $Y_{2_j} = 1$ (i.e., "1" represents those who state their WTP), while if $Y_{2_j} = 0$, there are no observations on $Y_{1_j}$ (i.e., "0" represents refusals). In this case, (6) may be rewritten as:

$$E(Y_{1_j} | X_{1_j}, \text{sample selection rule}) = X_{1_j}\beta_1 + E(u_{1_j} | u_{2_j} = 1 - X_{2_j}\beta_2). \quad (7)$$

Equation (7) indicates that the conditional mean of the disturbance term in the selected sample regression function, equation (3), is a function of $X_{2_j}$. The result is that $X_2$ variables that do not belong in the true structural equation may appear to be statistically significant in equations fitted on selected samples[16]. Heckman (1976, 1979) has proposed a simple estimation method to deal with the problem. Using well-known statistical results, he defines the omitted variable as $\lambda_j$, which is known as the "inverse Mills ratio".

$$\lambda_j = \phi(Z_j) / \Phi(Z_j) \quad (8)$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the normal probability density function and cumulative distribution function for the selection rule, respectively. In general, one does not know $Z_j$ and $\lambda_j$. However, in the above example in which "0" represents refusals, one does have information on $X_{2_j}$ for cases where $Y_{2_j} = 0$. Thus, one can compute the probability that an observation has data missing on $Y_1$, and then use that information to generate values for $Z_j$ and $\lambda_j$. This can be achieved in two steps: in the first step, a probit model is used to estimate the parameters of equation (4) for the entire sample. $Z_j$ is given by the vector of predicted values from this estimation and is then used to compute the $\lambda_j$ vector. In the second step, equation (3) is estimated with $\lambda_j$ as a regressor[17]. That is,

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[16] If the only regressor in $X_{2_j}$ is "1", so that the probability of selection is the same for all observations, the conditional mean of $u_{1_j}$ is a constant. In this case, bias occurs only in the intercept.

[17] This two-step procedure can be accomplished in one-step by using maximum

$$Y_{1j} = X_{1j}\beta_1 + \lambda_j\delta + \upsilon_j \quad (9)$$

The hypothesis to be tested, in the case of selection bias, is the following:

$$\text{H3:} \quad \delta = 0 \quad (10)$$

If H3 is rejected (i.e., selection bias is present), $\lambda_j$ is included in the estimated bid functions to correct for sample selection bias.

**Validity**

The final test is predicated on an attempt to derive tests of validity based on economic theory. We present below a test based on one of the axioms of consumer choice.

**Proposition 3:** If a bundle of goods is given by $\bar{X} = (X_1, X_2, \ldots\ldots X_n)$ then willingness-to-pay for $\bar{X}$ should exceed (or at least be equal to) willingness-to-pay for $X_1$, assuming non-negative marginal utility for the items included in the bundle. Thus, the hypothesis to be tested is:

$$\text{H4:} \quad WTP(\bar{X}) \geq WTP(X_1) \quad (11)$$

where $\bar{X}$ is a bundle of goods, and $X_1$ is an item included in that bundle.

**D. Experimental Design**

The purpose of this section is to outline the experimental design used to obtain the information for testing the various hypotheses outlined in the previous section.

The overall sample utilized for this study comprised of a random sample of 1,727 Alberta residents who purchased hunting licenses during the 1987/88 hunting season. This number represents two-thirds of a larger sample of 2,590 hunters surveyed in a study of wildlife recreational use in Alberta. The sample was random and therefore representative of the Alberta resident hunter population. The questionnaire design followed, insofar as possible, Dillman's (1978) "total design concepts". Although relatively lengthy (six pages and 27 questions on average), the questionnaires underwent several drafts, with input from the

[17](cont'd) likelihood estimation.

personnel of the Fish and Wildlife Division (Alberta Forestry, Lands and Wildlife) and Alberta Bureau of Statistics. They were also put through a number of pretests. The cover letters were not personalized due to the large numbers involved. However, each respondent received a professionally duplicated copy co-signed by the Assistant Deputy Minister of Alberta Forestry, Lands and Wildlife, and the Chairman of the Department of Rural Economy, University of Alberta.

Two sets of mailing labels were prepared to facilitate two mailings of each questionnaire. The first mailing took place on June 15, 1988. Six weeks later, the second mailing took place. Each respondent received a replacement questionnaire and a brief follow-up letter soliciting his or her co-operation. By the final cut-off date, six weeks after the final mailing, a response rate of 52% (as a proportion of the number of questionnaires delivered) had been achieved[18].

To test for framing effects (H1 and H2), annual contributions were elicited for a public trust fund set up to increase the grizzly bear population in a given area of the province currently closed to hunting. This area was clearly labeled on a map attached to the questionnaire. An explicit exclusion mechanism was instituted in that non-contributors would be unable to enjoy the benefits of the program - the opportunity to hunt grizzly bear in the area. Theoretically, option price can be defined as a state-independent willingness-to-pay (eg., see Graham 1981). Thus, to obtain one set of estimates for this test, approximately half of the sample (referred to below as Group 1) was asked for their option price estimates in the following manner:

> **"What is the MAXIMUM amount of money you are willing to pay each year to the grizzly bear fund, if there would be no refund of your money whether or not you decide to hunt after 5 years? $ _____."[19]**

The other half (referred to as Group 2) were asked for their option price estimates as

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[18] Since different sub-samples were utilized for each study, the reported reponse rates will differ slightly from the overall response rate.

[19] This particular question was one in a series of WTP questions in refund scheme designed to elicit points on the individual's "willingness-to-pay locus" (see chapter III).

follows:

**"How much would you be willing to pay annually to the grizzly bear fund to reserve your option of hunting grizzly bear after 5 years? $ _____."**

Respondents' bids for willingness-to-pay to hunt big game were used to test for selection bias (H3). Bids for both willingness-to-pay to hunt and to preserve big game, in general, and grizzly bear, in particular, were used to test for validity (H4). Willingness-to-pay to hunt (above normal hunting expenses) was elicited by asking respondents how much they would be willing to pay annually to engage in the given activity. Preservation values were elicited as an annual contribution to a hypothetical public trust fund set up to preserve wildlife in Alberta. The full-length questionnaires used to elicit the various bids can be found in the Appendix.

## E. Results and Discussion

### Test Results for Framing Effects

Prior to testing for framing effects (H1 and H2), the two subsamples (Groups 1 and 2, as above) were compared for differences. The variables compared were: AGE, EDUC (number of years of education including high school); EXP (annual hunting expenses, excluding capital expenditures); INC (annual household income); TRO (qualitative variable for the importance of trophy hunting, ranging from 1=very important to 6=least important); BAG (average number of species bagged per hunting trip); and SPEC (average number of species sought per hunting trip). Table II.1 shows that there were no significant differences between the two groups with respect to age, education, hunting expenditures, income, number of species bagged or sought and the importance of trophy hunting. A regression analysis also confirmed the absence of any significant differences between the two groups.

**Table II.1 Mean Characteristics of Subsamples used for Test of Framing Effects[a]**

| Variable | Group 1[b] | Group 2[b] | t-statistic |
|---|---|---|---|
| AGE | 37.52<br>(12.11) | 37.30<br>(13.57) | 0.22* |
| EDUC | 12.97<br>(3.01) | 13.02<br>(3.51) | -0.20* |
| EXP | 642.67<br>(754.67) | 566.76<br>(636.01) | 1.40* |
| INC | 40994<br>(20067) | 39006<br>(20797) | 0.04* |
| TRO | 2.40<br>(1.88) | 2.46<br>(1.92) | -0.01* |
| BAG | 8.80<br>(21.77) | 8.98<br>(21.36) | -0.11* |
| SPEC | 1.56<br>(0.88) | 1.54<br>(0.80) | 0.23* |
| N | 314 | 337 | |

[a] Standard deviations are in parentheses.

[b] The total sample of 1727 is divided into two groups. The numbers shown here represent those reporting their WTP values.

* Not significant at the .01 level using a two-tailed test.

Table II.2 presents results of the test of framing effects. It shows that Group 1's mean option price of $60.82 is not significantly different from the Group 2 mean of $77.29 at the .01 level, using a two-tailed test. While option price estimates from the two WTP question formats are not statistically significant in terms of magnitude, it is important to note that the mean bid for the second option price question is relatively higher. This appears to suggest that, perhaps, the explicit representation of uncertainty in the WTP question for Group 1 respondents may have forced them to research their preferences better, and perhaps take greater consideration of their budget constraints. This hypothesis is supported by the test of equality between the two variances (see lower section of Table II.2) which shows that the Group 2 variance (19210.48) is significantly larger than that of Group 1 (12476.95) at the .01 level, using a one-tailed test. Thus, it may be concluded that, on average, Group 1 responses were more accurate than those of Group 2. In general, these results indicate that there was no significant misperception of the hypothetical commodity. However, differences in the WTP question format may have affected the accuracy or precision of the reported values. Boyle (1989) reached a similar conclusion in a CV study of trout fishery in southern Wisconsin streams.

**Test Results for Selection Bias**

As mentioned earlier, the two-step Heckman procedure for testing selection bias involved estimating $\lambda_j$ from a probit analysis, and including it as a predictor in an OLS model. The first stage (probit) estimation included the following socioeconomic variables - age, education, hunting expenditure and income, and the hunting-related variables - species sought (SPEC) and bagged (BAG), as well as the importance of trophy hunting (TRO). The results of these estimations are reported in Table II.3. In Model I, the dependent variable is the probability of making a nonzero bid. It can be seen that, in relative terms, older and more educated hunters with higher expenditures have a tendency to give zero bids. However, the relationships are weak, given the insignificant coefficients. The hunting variables, BAG and

**Table II.2 Results for Test of Framing Effects[a,b]**

| Variable | Group 1 Mean | Group 1 Median | Group 2 Mean | Group 2 Median | |
|---|---|---|---|---|---|
| | | | | | t-statistic |
| WTP[c] | \$60.82 (111.70) | \$25.00 | \$77.29 (138.60) | \$50.00 | -1.51[e] |
| | | | | | F-statistic[d] |
| $s^2$ | 12476.95 | | 19210.48 | | 1.54[f] |
| N | 260 | | 272 | | |

[a] $H_0$: WTP(Q1) = WTP(Q2); $H_A$: WTP(Q1) ≠ WTP(Q2), where Q1 and Q2 are two different definitions of option price (see text).

[b] Standard deviations are in parentheses.

[c] WTP is annual willingness to contribute into a trust fund for the option of hunting after five years, i.e option price.

[d] $H_0$: $s^2(2) = s^2(1)$; $H_A$: $s^2(2) > s^2(1)$, where $s^2(i)$ is variance for Group i=1,2. $F=s^2(2)/s^2(1)$, df=N(2)-1, N(1)-1.

[e] Not significant at the .01 level using a two-tailed test.

[f] Significant at the .01 level using a one-tailed test.

SPEC are insignificant in the decision to make a nonzero bid. In contrast, those who place more importance on trophy hunting have higher probabilities of making a nonzero bid.

In Model II, the dependent variable is the probability of a bid being nonzero or an outlier[20]. In this model, an increase in hunting expenditures increases the probability of making a zero or a very large bid. The dependent variable in the last probit estimation (Model III) represents the probability of responding to the WTP question (i.e., 0 = refusal to respond). It can be seen here that the probability of responding increases with hunting expenditure. The results also suggest that the variables BAG and SPEC are also significant. However, it is not intuitively clear how such variables affect the decision not to respond to the WTP question. Nevertheless, based on the role of expenditures, one may speculate that those who report their personal valuations tend to be people engaging in relatively high levels of hunting activities. Perhaps, such people are better able to assess their preferences due to more experience.

The results of the second stage estimations are reported in Table II.4. Three different Heckman models were estimated. These were: Model IV - an OLS model with zero bids excluded; Model V - an OLS model with zero bids and outliers excluded; and finally, Model VI - an OLS model including all bids except refusals. The models were estimated using a heteroscedasticity-consistent covariance matrix (see White 1980) to account for heteroscedasticity found in preliminary tests. The results show that the coefficient of income has the expected sign in all three models, and is significant in Models IV and VI. It is expected that willingness-to-pay should increase with expenditure. This result is observed for Models V and VI in which the respective income coefficients are also significant. The income coefficient has an inconsistent sign in Model I but is insignificant. Of the other socioeconomic variables, age is positive and significant in Model V. The coefficient of trophy hunting is negative and significant in Models V and VI. The negative sign is explained by the fact that as the importance of trophy hunting increases (i.e., a movement from 6 to 1 on the scale),

[20] Outliers were determined by means of Belsley et al's 1986 diagnostic techniques. The results are reported in Appendix 1.

**Table II.3 Probit Analyses of Zero Bidders, Outliers and Refusals[a]**

| Variable | Model I[b] | Model II[c] | Model III[d] |
|---|---|---|---|
| Constant | 0.6692 | 0.7205 | 0.6003 |
| | (2.1248)** | (2.3023)*** | (1.9573)*** |
| TRO | 0.0612 | 0.0779 | -0.0103 |
| | (2.0745)** | (2.6489)*** | (-0.3197) |
| BAG | 0.0015 | -0.0013 | -0.0058 |
| | (0.5283) | (-0.5252) | (-2.8712)*** |
| SPEC | 0.0538 | 0.0706 | 0.2554 |
| | (0.8005) | (1.0571) | (3.6569)*** |
| AGE | -0.0011 | -0.0037 | -0.0051 |
| | (-0.2298) | (-0.8103) | (-1.1467) |
| EDUC | -0.0128 | -0.0071 | 0.0172 |
| | (-0.7264) | (-0.4065) | (0.9330) |
| EXP | -0.00008 | -0.0029 | 0.00019 |
| | (-1.0372) | (-3.8615)*** | (1.8727)* |
| INC | 0.0017 | 0.0016 | 0.0026 |
| | (0.6088) | (0.5484) | (0.8957) |
| Log-likelihood Function | -351.15 | -359.91 | -284.01 |
| LRT[e] | 7.65 | 25.76*** | 29.31*** |
| Cragg-Uhler $R^2$ | 0.02 | 0.06 | 0.07 |

[a] Standard deviations are in parentheses.
[b] The dependent variable is Prob. (Bid > 0) where 1=all bids and 0=zero bids, N=651 of which 153 are zero bids.
[c] The dependent variable is Prob. (Bid > 0) where 1=nonzero bids and 0=zero bids and outliers, N=651 of which 16 are outliers.
[d] The dependent variable is Prob. (Bid> 0) where 1=all bids and 0=refusals, N=888 of which 102 are refusals.
[e] LRT is likelihood ratio test at 7 degrees of freedom.
*** Significant at the .01 level using a one-tailed test.
** Significant at the .05 level using a one-tailed test.
* Significant at the .10 level using a one-tailed test.

**Table II.4 Results for Tests of Selection Bias[a]**

| Variable | Model IV[b] | Model V[b] | Model VI[b] |
|---|---|---|---|
| Constant | -10622 | 1553.1 | -1422.6 |
| | (-1.1756) | (1.5061)* | (-1.1806) |
| TRO | 203.26 | -46.504 | -11.187 |
| | (1.1115) | (-1.6949)** | (-1.5326)* |
| BAG | 4.7599 | 0.4929 | -2.3686 |
| | (1.2392) | (0.7595) | (-1.0156) |
| SPEC | 203.05 | -27.689 | 91.311 |
| | (1.2659) | (-1.0286) | (1.3952)* |
| AGE | -1.6812 | 3.3858 | -0.0749 |
| | (-0.5001) | (2.2519)*** | (-0.0457) |
| EDUC | -41.192 | 3.1212 | 8.4083 |
| | (-1.1355) | (0.8136) | (0.9584) |
| EXP | -0.0824 | 0.2877 | 0.2152 |
| | (-0.3996) | (2.4397)*** | (2.3198)*** |
| INC | 7.4458 | 0.1304 | 1.9907 |
| | (1.3735)** | (0.1618) | (1.9223)** |
| $\lambda_j$[c] | 27134 | -3824.0 | -3599.7 |
| | (1.1799) | (-1.4329)* | (1.2164) |
| $R^2$ | 0.2120 | 0.0950 | 0.1321 |
| $R^2$ adj. | 0.1991 | 0.0797 | 0.1213 |
| F | 16.44*** | 6.21*** | 12.21*** |
| N | 498 | 482 | 651 |

[a] Standard deviations are in parentheses.
[b] Models IV-VI are as follows: IV=excludes zero bids; V=excludes zeros and outliers; and IV=includes all bids except refusals.
[c] $\lambda_j$ is "inverse" Mills ratio.
*** Significant at the .01 level using a one-tailed test.
** Significant at the .05 level using a one-tailed test.
* Significant at the .10 level using a one-tailed test.

willingness-to-pay increases.

The results for selection bias can be ascertained from the t-ratios for the $\lambda_j$ coefficients. No significant selection bias is caused by deleting zero bids (see lower section of column 2). However, deleting zero bids and outliers causes some selection bias, judging from the $\lambda_j$ coefficient in column 3 which is significant at the .10 level. Finally, the results for Model VI indicate that no significant bias is caused by self-selection due to nonresponse to the WTP question. Models IV and V represent typical applications of the Heckman procedure in recent contingent valuation studies (eg., see Edwards and Anderson 1987; Desvousges et al. 1987). However, the merits of this form of testing must be questioned in view of the fact that it actually applies to the type of selection bias caused by the researcher himself (i.e., by culling so-called unreasonable bids). It is suggested here that a more legitimate approach is to test for self-selection due to nonresponse or refusals. Such an approach is adopted in Model VI, where the $X_2$ variables include information on people who refused to answer the WTP question. The resulting t-test therefore provides a more meaningful test of whether self-selection is indeed random.

One type of analysis which is often ignored in CV studies, but which could yield valuable information, is the detailed analysis of the characteristics of zero bidders, outliers and refusals[21]. Also important is the analysis of nonrespondents which is often precluded by budget constraints. Table II.5 presents results for the mean characteristics of all bids, zero bids, nonzero bids (excluding outliers), outliers and refusals. There are no significant differences in socioeconomic and hunting characteristics of zero bidders compared to all others. The t-ratios for outliers suggest that, while there are no significant income or educational differences *vis-a-vis* other bidders, this particular group of bidders tend to be relatively older people who incur higher hunting expenditures. Refusals also do not differ significantly with regard to income or age, compared to all other bidders. However, unlike those whose responses are outliers, they tend to be significantly younger and spend less on

[21] Note that "refusals", as used in this context, refers to those responding to the questionnaire but not answering the given WTP question.

Table II.5 Mean Characteristics by Type of Bid[a]

| Category | AGE | EDUC | EXP | INC[b] | TRO | BAG | SPEC | N |
|---|---|---|---|---|---|---|---|---|
| I. All Bids | 37.0 | 13.0 | 603.37 | 42423 | 2.43 | 8.9 | 1.55 | 651 |
| | (11.9) | (3.3) | (696.27) | (18454) | (1.90) | (21.5) | (0.84) | |
| II. Zero Bids | 38.0 | 13.1 | 650.78 | 43157 | 2.13 | 7.7 | 1.49 | 153 |
| | (10.8) | (3.3) | (704.93) | (18207) | (1.91) | (17.3) | 0.81 | |
| t[c] | -0.68 | -0.33 | -0.76 | 0.42 | 1.43 | 0.62 | 0.08 | |
| III. Nonzero Bids (excl. outliers) | 36.6 | 13.0 | 537.59 | 41893 | 2.55 | 8.8 | 1.57 | 482 |
| | (12.2) | (3.1) | (552.02) | (18530) | (1.90) | (21.1) | (0.85) | |
| IV. Outliers | 43.5 | 12.4 | 2131.90 | 51175 | 1.56 | 22.4 | 1.35 | 16 |
| | (12.4) | (6.0) | (1883.10) | (15568) | (1.26) | (50.0) | (0.73) | |
| t[d] | -2.20 | 0.70 | -2.24* | -1.93 | 1.42 | -2.93* | 1.00 | |
| V. Refusals | 39.2 | 12.3 | 456.55 | 41649 | 2.39 | 14.3 | 1.19 | 102 |
| | (14.3) | (3.4) | (625.77) | (19851) | (1.80) | (37.7) | (1.00) | |
| t[e] | 1.69 | 2.10* | 2.73* | 0.36 | 0.20 | 2.08* | 2.06* | |

[a] Standard deviations are in parentheses.
[b] Sample sizes for income categories differ from the reported values for N due to nonresponse, and are available from the author.
[c] t-statistic calculated using categories I and II.
[d] t-statistic calculated using categories I and IV.
[e] t-statistic calculated using categories I and V.
* Significant at the .01 level using a two-tailed test.

hunting activities.

A number of important conclusions emerge from the above analysis. First, given the format of the WTP question ("how much are you willing to pay, over and above your normal hunting expenses, to hunt?"), it is conceivable that zero values are not necessarily protest bids. Rather, zero bids could be a reflection of the fact that respondents have exhausted their consumers' surplus[22]. This hypothesis is supported by the relatively higher expenditure levels observed for zero bidders. Second, a similar conclusion can be reached in the case of outliers. Responses perceived as outliers could in fact be genuinely high bids. It is also possible that this category of bidders has unusual preference functions, judging from the high expenditures. The results for refusals indicate a high correlation between hunting expenditure and responding to the WTP question. This may suggest that some people refuse to respond to the WTP question due to uncertainty about their valuations stemming from low level activity.

In conclusion, the above results do not provide justification for the practice of deleting outliers and zero bids. In their attempts to produce 'reasonable' data sets for analysis, economists could in fact be disposing of valuable information.

**Test Results for Validity**

One objective of the on-going attempts to validate WTP measures should be to verify whether CVM bids are consistent with the axioms of consumer choice. This appears to be a more theoretically valid approach than, say, comparing CVM estimates to those obtained from other methodologies. The last test reported in this study is based on the notion of weak monotonicity, or local nonsatiation (Varian 1984). According to this proposition, more is preferred to less, within certain limits. Table II.6 presents results for difference of means and nonparametric tests. It can be seen that annual willingness-to-pay for big game hunting ($205.93) is significantly higher than that for grizzly bear hunting ($149.29), using both a t-test and a Wilcoxon signed ranks test. Following the same trend, the annual preservation

[22] The actual incidence of actual protest bids as manifested by respondents' comments in the space provided was low for this study.

**Table II.6 Results for Test of Validity[a,b]**

| Variable | Big Game | Grizzly Bear | t | W[e] |
|---|---|---|---|---|
| WTP[c] | $205.93<br>(111.70) | $149.29<br>(138.60) | 2.85* | -7.18* |
| N | 651 | 629 | | |
| PV[d] | (Wildlife)<br>$77.87<br>(132.20) | $51.06<br>(98.39) | 4.56* | -12.37* |
| N | 806 | 776 | | |

[a] The null hypothesis is WTP $(\bar{X})$ = WTP $(X_1)$, where $X_1$ is grizzly bear and $\bar{X}$ is big game or wildlife.

[b] Standard deviations are in parentheses.

[c] WTP is annual willingness-to-pay to hunt.

[d] PV is annual preservation value.

[e] W is Z score calculated from a Wilcoxon matched-pairs signed-ranks test.

* Significant at the .01 level.

value for wildlife ($77.87) is also significantly higher than that for grizzly bear ($51.06). Thus the null hypothesis of monotonicity cannot be rejected in both cases[23]. It may be concluded, from the test results, that the CV bids obtained in the study satisfy the principle of nonsatiation.

**F. Summary and Implications**

This study has attempted to address the complex issue of bias in contingent valuation surveys. In a test of framing effects based on different representations of the same value measure, the null hypothesis of equality of means could not be rejected. However, the null hypothesis of equality of variances was rejected in favor of the alternate hypothesis. One implication of this result is that in attempting to improve the accuracy of CV value estimates, it is not sufficient to ensure that Cummings et al's (1986) Reference Operating Conditions (ROC's) are satisfied[24]. Efforts must be made to implement variance reducing measures such as refining the description of the contingent market, including the commodity to be valued. In this test, explicit representation of uncertainty in one of two willingness-to-pay questions did not produce significant differences in the magnitude of the reported values. However, there were significant differences in accuracy (or precision) as reflected by the group variances. In general, the results underscore our assertion that certain facets of the contingent market scenario (eg., information provided) must not be viewed as a source of bias insofar as they enhance the respondent's understanding of the valuation task.

The issue of selection bias was dealt with next. In an application of Heckman's (1979) test of selection bias, the null hypothesis of no selection bias could not be rejected in the case where outliers and zero bids were deleted. The merits of the Heckman procedure, as typically applied in CV studies, was questioned in view of the fact that it merely tests for selection bias

[23] For hunters who preferred to hunt only one species of big game, the monotonicity assumption breaks down if that species is not grizzly bear. However, since (i) these tests are based on average values, and (ii) the average hunter in the study sought more than one species, the results are still meaningful.

[24] The ROC's may have been satisfied in this case since the average hunting experience for the sample is 18 years.

caused by the researcher himself. It was suggested that a more legitimate approach would be to test for self-selection due to nonresponse. Zero and high bidders were shown to have high levels of hunting expenditures, suggesting that those bids could be genuine. In the case of the former category, the zero bids could be a reflection of the fact that they had fully extracted their consumer's surplus. In the case of the latter category, further research could unravel their particular pattern of bidding.

This study emphasized the need for CV researchers to routinely test CV responses as a means of establishing the validity of the methodology. However, the basis of "comparison tests" (which are fairly popular in the literature) was questioned in that statements about how well measures from the CVM and the other methods approximate the true underlying value cannot be ascertained from the comparisons. A case was made for devising testable hypotheses derived from economic theory. One such test reported here showed that the CV responses accorded with one of the axioms of consumer choice, namely, the principle of nonsatiation. In general, the study provides support for the view that the CVM is capable of providing reliable estimates for policy analysis, given that most of the ROC's are satisfied. It has pointed out hitherto overlooked problems inherent in recently adopted testing procedures. It is hoped that future research efforts would result in the development of more superior forms of testing, to enhance confidence in the methodology.

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## III. Nonmarket Valuation under Uncertainty

### A. Introduction

Estimation of the value of nonmarket commodities has made much progress since the pioneering efforts of Hotelling (1947), Ciriacy-Wantrup (1952), Clawson (1959) and Davis (1963). However, an issue which continues to elude researchers is uncertainty. Early contributors to the literature on resource valuation (eg., Eckstein 1958) recognised the importance of uncertainty but chose to deal with the problem indirectly by means of the discount rate. In the area of benefit estimation, economists followed closely the tenets of neoclassical economic theory which is predicated on an assumption of perfect certainty (or knowledge). Within this framework, an appropriate measure of benefits was taken to be the consumer's surplus associated with the use of a given commodity. This procedure has now been shown to be unsatisfactory in that it ignores uncertainty.

Weisbrod (1964) was among the first economists to acknowledge the need to explicitly account for uncertainty in resource valuation[25]. Friedman (1962) had earlier argued that if the commercial value of lumber for, say, a national park exceeded the willingness-to-pay for noncommercial use, then it should be closed down. In response, Weisbrod argued that such a policy would be socially undesirable since there might be some people, who although not current users, might nevertheless place a significant value on consuming the resource in the future. He referred to this as option value[26]. Concern about the role of uncertainty gave rise to a search for new methods of resource valuation. Initially, attention was focused on expected consumer's surplus and option value. The latter was generally regarded as a "risk

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[25] Perhaps, this development can partly be explained by the fact that the theoretical framework for modeling uncertainty was borrowed from the theory of insurance (Cook and Graham 1977). The general thinking of the insurance approach is that an individual will purchase an option as a hedge against future adverse price or income shocks.

[26] Option value, as used here, is a static (time-independent) concept and is not to be confused with quasi-option value (Arrow and Fisher 1974, Henry 1974), which is a dynamic concept. Essentially, the latter refers to multiperiod maximization of net benefits given irreversibility and uncertainty.

premium" that an uncertain consumer would pay to ensure supply.

The option value concept came under heavy challenge with long and often confusing debates about whether it was positive (as envisioned by Weisbrod), negative or zero (Long 1967; Lindsay 1969; Cicchetti and Freeman 1971; Schmalensee 1972; Bohm 1975). Later theoretical contributions (eg., Bishop 1982, 1986; Smith 1983; Freeman 1984) proved that option value could be either positive, negative or even zero depending on the particular circumstances[27]. In the last few years, however, theoretical developments have occurred which have changed the context of the debate. In particular, it has been suggested that option price, and not option value, should be the variable of interest in attempts to obtain appropriate empirical estimates of resource values under uncertainty. In his seminal article on cost-benefit analysis under uncertainty, Graham (1981) argues that option price is the appropriate benefit measure assuming identical individuals and collective risks, while the expected fair-bet point is appropriate assuming identical individuals and individual risks[28].

Much of the literature cited above focuses almost exclusively on demand uncertainty. Thus option value, as defined above, is commonly viewed as a demand-side phenomenon. That is, option value exists because individuals are uncertain about their future demand for the given commodity. Cicchetti and Freeman (1971) were the first to suggest that option value could also exist if supply were uncertain. However, they did not proceed to formally develop the concept of "supply side" option value. In Bishop's (1982) wide-ranging exposition on option value, a strong case was made for the relevance of "supply side" option value to many natural resource and environmental issues. Brookshire et al. (1983) took the argument a step further by suggesting that without the presence of supply uncertainty, option value is nonexistent. They posed the following question: "Why would there be a willingness to pay for the option to future use of a natural environment if future availability of the environment is

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[27] See also, Anderson (1981); Freeman (1985); Plummer (1985); Plummer and Hartman (1986); Graham-Tomasi and Wen (1987) and Wilman (1987), for further discussion on the sign of option value.

[28] The terms option price and the expected fair-bet point are formally defined in the following section.

certain?" (Brookshire et al. 1983, p.3).

The issue of which aspect of uncertainty is dominant appears to be an empirical moot point which depends on the characteristics of the commodity and a complex array of other factors. Nevertheless, it has become apparent that there is a need to give some attention to supply uncertainty. This paper reports the results of a study which analyzes, separately, the issues of demand and supply uncertainty within the context of nonmarket valuation of grizzly bear hunting in Alberta. The theory of Expected Utiltity (von Neumann and Morgenstern 1944), together with its varaints [eg., state-dependent EU (Cook and Graham 1977) and weighted EU (Chew and MacCrimmon 1979)], has long been used as a paradigm of rational behavior in economics. In recent years, the model has been severely criticised for being an inadequate representation of consumer behavior [see, for example, Arrow (1982), Simon (1979) and Shoemaker 1982)]. Theories such as Prospect Theory (Kahneman and Tversky 1979), Regret Theory (Loomes and Sugden 1982, Bell 1982), Reliability Theory (Heiner 1983) and Cognitive Dissonance (Akerlof and Dickens 1982) have been offered as alternative models of rational behavior.

In this study, tests are devised to ascertain whether respondents behave according to the postulates of EU theory. A new methodology for estimating benefits when demand is uncertain, which was tested in Asafu-Adjaye et al. (1988), is applied. The effects of supply uncertainty and socioeconomic variables on the magnitude of option price are also examined. The issue of supply uncertainty, as far as the grizzly bear resource is concerned, is an important one in Alberta. The grizzly bear population in the province has been declining due to deteriorating habitat quality and increased contact with humans. This decline has also been exacerbated by the increasing use of natural wildlife habitat for nonhunting purposes such as agriculture and mining. While the grizzly bear is relatively scarce compared to most other big game species (eg., moose, deer), there is a high demand for grizzly bear hunting licenses[29].

[29] According to Gunson (1988), there are about 809 grizzly bears in Alberta. Over the period 1986 to 1987, a total of 3709 applications were made for grizzly bear hunting licenses of which only 359 were awarded by lottery (Alberta Forests, Lands and Wildlife 1987).

The study is structured as follows: section two presents the theoretical models applied in the study, including tests of hypotheses. Section three discusses the experimental design which includes the questionnaire design and survey procedure. Section four contains the results and discussion. Section five concludes with the summary and implications.

## B. Theoretical Models

### A Theoretical Model of Demand Uncertainty

Conceptually, the problem of determining the theoretically appropriate measure of benefits given uncertain demand could be solved in two steps. First, one would identify all the possible contingent-payment contracts to which the uncertain user would voluntarily agree to ensure future supply, given different states of the world. To keep the analysis within manageable limits, it will be assumed that only two states of the world occur: a demand state and a no-demand state. The final step in this process would be to identify the contingent-contract pair of payments which yields the maximum expected value.

Let $U_1$ and $U_0$ be the consumer's indirect utility functions in the demand and no-demand states, respectively. Let $P_1$ and $P_0$ be vectors of prices in the two states, respectively. To further simplify the analysis, let Y be a state-independent income level. Let the probabilities agreed to by all be $\Pi_1$ and $\Pi_0$ for demand and no-demand states, respectively. Assume that to guarantee future supply, the consumer has contracted to make the following contingent payments: $C_1$ in the event of a demand state ocurring, and $C_0$ in the event of a no-demand state ocurring. In the absence of such an arrangement, the consumer is excluded from purchasing the commodity. In this case, the state-dependent expected utility function may be written as follows:

$$\bar{U} = \Pi_1 U_1 (Y, P_1, \delta^0) + \Pi_0 U_0 (Y, P_0, \delta^0) \qquad (1)$$

where $\delta^0$ indicates that the commodity is not available. Assuming economic rationality, the consumer will not consent to a contingent contract resulting in a utility below $\bar{U}$. It has been

shown in the recent literature (e.g., see Bishop 1986) that there are a number of potential measures of benefits under uncertainty which satisfy condition (1). The most well-known is expected surplus, E(S). Let $S_i$ be consumer's surplus in demand state i. Then E(S) is given by:

$$E(S) = \Pi_1 S_1 + \Pi_0 S_0 \tag{2}$$

where $S_1$ and $S_0$ are, respectively, defined by the following conditions:

$$U_1 (Y - S_1, P_1, \delta^1) = U_1 (Y, P_1, \delta^0) \tag{3}$$

$$U_0 (Y - S_0, P_0, \delta^1) = U_0 (Y, P_0, \delta^0) \tag{4}$$

where $\delta^1$ indicates that the commodity is available. Substituting (3) and (4) into (1), we obtain:

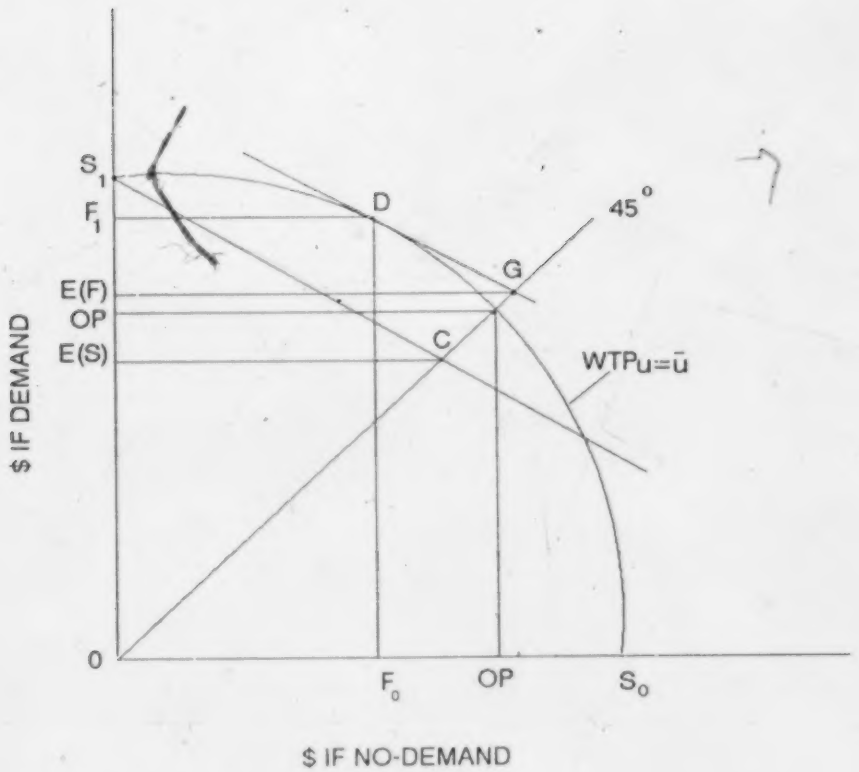
$$\bar{U} = \Pi_1 U_1 (Y - S_1, P_1, \delta^1) + \Pi_0 (Y - S_0, P_0, \delta^1) \tag{5}$$

To obtain option price (OP), the maximum state independent willingness-to-pay, we substitute $C_1 = C_0 = OP$ into equation (5) for $S_1$ and $S_0$. In general, $C_0$ and $C_1$ represent alternative contingent payments. Thus, Equation (5) provides a locus of contingent payment contract pairs referred to as the *willingness-to-pay locus* (Graham 1981). It traces the pairs of points at which the consumer is indifferent between making a contingent payment to ensure supply. Another measure of benefits under uncertainty can be obtained by finding the contingent pair on this locus which has the maximum expected value. This combination is referred to as the *fair-bet* point[30].

Figure III.1 shows the alternate benefit measures for the demand and no demand states. The surplus in the demand state is $S_1$ while the surplus in the no demand state is zero. The expected surplus E(S) is obtained by passing a line representing the ratio of state probabilities through the point $S_1$ and the 45° line. Option price is indicated by the point G and the fair bet point is point D. The expected values of option price and the fair bet point are given by OP and E(F) respectively. The corollary of the *willingness-to-pay locus* is the *willingness-to-accept locus* which is convex to the origin for the risk averse individual (eg., see

[30] The existence of the fair-bet point is predicated on an assumption of perfect insurance markets.

**Figure III.1** *The Willingness-to-Pay (WTP) Locus*



Graham-Tomasi and Myers 1987). In this case, the fair-bet point is given by the contingent payment pair with the minimal expected value.

Equations (2) and (5), together with Figure III.1, form the basis of the test of the EU model. If there is no demand uncertainty, i.e. $\Pi_1 = 1$, the line representing the ratio of state probabilities is horizontal and tangent to the WTP locus at $S_1$. In this case, $S_1 = OP = E(S)$, or $S_1 - OP = 0$. On the other hand, if respondents are less than certain about future demand, i.e. $\Pi_1 < 1$, we expect $S_1$ to be greater than, or at least equal to OP if they are maximizing expected utility[31]. The above hypotheses may be summarised as follows:

**H1:** For certain demanders, $S_1$ is equal to OP.

**H2:** For uncertain demanders, $S_1$ is greater than or equal to OP.

An additonal hypothesis is the following:

**H3:** Among uncertain demanders, the greater the degree of uncertainty, the greater the difference between $S_1$ and OP.

These hypotheses suggest that: (i) if respondents can be disaggregated into certain and uncertain demanders, then among certain demanders we must observe a higher proportion of cases for which $S_1 = OP$; (ii) among uncertain demanders, we must observe a higher proportion of cases for which $S_1$ is greater than OP. H2 may be viewed as a weak test of rationality because it only requires that $S_1$ be greater or equal to OP. A much stronger test is H3 which requires an association between the level of uncertainty and the size of the option premium.

**A Theoretical Model of Supply Uncertainty**

In this model, the good to be supplied is a grizzly bear hunting license. Assume that the consumer's utility function can be defined as $U(Y, \delta)$, where Y is income and $\delta$ is the level of provision of the given environmental resource commodity. Assume that there are only two levels of supply of the commodity: $\delta > 0$ and $\delta = 0$. The current probability that the

[31] This relationship presumes that respondents are either risk averse or risk neutral.

good will be supplied is $\rho_2$, where $0 < \rho_2 < 1$ and $\rho_1 = 1 - \rho_2$. Finally, assume that demand is certain and that there are no contingent markets.

The compensating variation measure of consumer's surplus for a grizzly bear hunting license can be defined by:

$$U(Y, 0) = U(Y - S, \delta) = \bar{U} \tag{6}$$

where $\bar{U}$ is the reference level of utility and S is willingness-to-pay for a grizzly bear hunting license. Assume now that there is a program that will increase the probability of being supplied with a hunting license from $\rho_2$ to $\pi_2$, i.e. $\pi_2 \geq \rho_2$. Let $EU_w$ be expected utility with the program and let $EU_{wo}$ be expected utility without the program. The latter may be written as:

$$EU_{wo} = \rho_1 U(Y, 0) + \rho_2 U(Y, \delta) \tag{7}$$

Given supply uncertainty, one measure of benefits is option price, OP, which is the maximum state-independent amount consumers are willing to pay for the program. For example, if $\pi_2 = .90$, then the consumer's option price bid will represent a 90% chance of being supplied (or a 10% chance of not being supplied) with a grizzly bear hunting license. Thus the option price payment equates expected utility with the project to expected utility without it. That is, OP is defined by:

$$EU_{wo} = EU_w \tag{8}$$

where $EU_w = \pi_1 U(Y - OP, 0) + \pi_2 U(Y - OP, \delta)$.

By substituting (7) on the left hand side of equation (8), we obtain an expression relating option price to compensating variation as follows:

$$\rho_1 U(Y, 0) + \rho_2 U(Y, \delta) = \pi_1 U(Y - OP, 0) + \pi_2 U(Y - OP, \delta) \tag{9a}$$

and by substituting for U(Y, 0) above using equation (6), we obtain

$$\rho_1 U(Y - S, \delta) + \rho_2 U(Y, \delta) = \pi_1 U(Y - OP, 0) + \pi_2 U(Y - OP, \delta) \tag{9b}$$

In this application, expected consumer's surplus, E(S), can be defined as the increase in expected surplus given the project. That is,

$$E(S) = (\pi_2 - \rho_2)S \tag{10}$$

Equation 9b can be viewed as a generalized model of supply uncertainty which may be adapted to fit particular cases (eg., see Freeman 1985, Plummer 1986), depending on whether or not there is a possibility of supply without the program (i.e., $\rho_2 > 0$ or $\rho_2 = 0$) and also depending on whether the option is sure ($\pi_2 = 1$) or unsure ($\pi_2 < 1$). For example, if there is no possibility of supply without the program but supply is guaranteed with the program (i.e., $\rho_2 = 0$ and $\pi_2 = 1$), equation (9b) reduces to

$$U(Y - S, \delta) = U(Y - OP, \delta) \tag{11}$$

Therefore:

$$OP = E(S) = (\pi_2 - \rho_2)S \tag{12}$$

This is the special case of perfect certainty, where it can be seen that $\pi_2 - \rho_2 = 1$. In this case, supply side option value, SSOV, which is the difference between option price and expected consumer's surplus, E(S), is zero.

In the present study, there is a situation of a positive but low probability (about 5%) of obtaining a hunting license. However, it is assumed that the proposed program would greatly increase the probability of supply, therefore $0 < \rho_2 < \pi_2 < 1$. Given these conditions, the sign of SSOV is theoretically indeterminate since option price could be greater or less than expected consumer's surplus (Freeman 1985)[32].

The test of rationality in the case of supply uncertainty can be derived from equations (9b) and (12). If the proposed wildlife management program fails to change the probability of supply of a hunting license, i.e. $\pi_2 = \rho_2$, then option price is zero by definition (see equation 12). On the other hand, if supply uncertainty is eliminated given the program, i.e. $\pi_2 = 1$, and there is currently no supply without the program, i.e. $\rho_2 = 0$, then (12) suggests that OP = S. From the foregoing, it can be seen that for a rational consumer, OP wil be an increasing function of $\pi_2$ for low values of $\rho_2$. Thus, to test for rationality, it is necessary to show that:

[32] It has been shown that when there is some possibility of supply without the program but suuply is guaranteed with the program (i.e., $\rho_2 > 0$ and $\pi_2 = 1$), the sign of SSOV is positive for the risk averse individual (see Plummer 1986).

$$H4: OP(\pi_2 = .90) > OP(\pi_2 = .50) > OP(\pi_2 = .10) \quad (13)$$

Also, for a given level of probability of supply of a hunting license, we would expect option price for certain demanders to exceed that of uncertain demanders. That is:

$$H5: OP(\Pi_1 = 1.0) > OP(\Pi_1 < 1) \quad (14)$$

where $\Pi_1$ is the probability of demand, as defined previously.

**C. Experimental Design**

The respondents in this study comprised of a random sample of 1,727 Alberta residents who purchased hunting licenses during the 1987/88 hunting season. The overall response rate, as a proportion of the total number of questionnaires delivered, was 50%. The respondents were participants in a survey of wildlife recreational values in Alberta, and had indicated in an earlier portion of that survey that they would like to hunt grizzly bear sometime in the future. The sample was randomly divided into two groups for the purpose of analysing demand and supply uncertainty. In a short preamble to the study, respondents were informed about the purpose of the experiment. In particular, they were informed that it was hypothetical and not in any way a reflection of future government policy[33].

Both groups received the same basic description of the contingent market situation. This was presented as a public trust fund to finance a 5-year wildlife management program to increase the grizzly bear population in an area currently closed to hunting. This area was clearly designated on a provincial map attached to the questionnaire. Respondents in the first group (demand uncertainty) were informed that annual contribution to this fund would guarantee them indefinite access to the area after the prescribed period of five years. The second group (supply uncertainty) were informed that annual contribution to the fund would

[33] This caution was deemed necessary in view of the fact that cover letters for the survey were jointly signed by an Assistant Deputy Minister of Alberta Forestry, Lands and Wildlife, and by the Chairman of the Department of Rural Economy, University of Alberta. While the former's approval would give the survey some authenticity, we acknowledge the fact that it could also be a source of bias. For example, people dissatisfied with government policy might register protest bids or decline to participate.

enhance their chances of obtaining a grizzly bear hunting license. An exclusion mechanism was established in that only those contributing to the fund would be considered for access to the designated area.

Since option price has been defined as state-independent willingness-to-pay, demand-side option price (OP or point G, figure III.1) was elicited as follows:[34]

> **"What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund, each year, if there will be NO REFUND of your money should you decide not to go hunting after 5 years? $ _____."**

Conditional consumer's surplus, $(0, S_1)$ on figure III.1, was elicited as follows:

> **"What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund, each year, if there will be a FULL REFUND of your money should you decide not to go hunting after 5 years? $ _____."**

An attempt was made to obtain an additional conditional surplus measure between $S_1$ and G $(S_0, S_1)$ as follows:

> **"What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund, each year, if half of your money will be refunded to you should you decide not to go hunting after 5 years? $ _____."**[35]

Finally, point $(S_0, 0)$ was elicited as follows:

> **"What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund, each year, if there will be a FULL REFUND of your money should you decide to go hunting after 5 years? $ _____."**

Supply-side option price bids (equation 9b) were elicited as follows:

> **"What is the MAXIMUM amount of money you are willing to pay each year to the grizzly bear fund if there are high chances, 9 in 10, of you getting a grizzly bear hunting license after 5 years? $ _____."**

Bids were also elicited at two additional levels of probability - 50% and 10%[36]. Both groups of

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[34] It is to be noted that attempts have been made to minimize "supply uncertainty" by guaranteeing indefinite access.

[35] Unfortunately, this question was not well structured and therefore produced an interior point on the WTP locus.

[36] The reason for restricting the levels of probability to three are that, (i) given the complexities of probability perception, respondents would probably be hard pressed to discern between several levels of probability and, (ii) too many willingness-to-pay might reduce valuation accuracy or reduce response rates.

respondents were questioned about their chances of hunting grizzly bear if they obtained a hunting license. These demand probability measures were obtained at four levels - certain, even odds, low odds and zero odds. The survey concluded with questions on the usual socioeconomic characteristics - place of residence, sex, age, education, family size, and income.

## D. Empirical Results and Discussion

### Demand Uncertainty

Table III.1 displays results for the frequency distribution, means, standard deviations and 95% confidence intervals for option price and the three measures of conditional consumer's surplus, $(0, S_1)$, $(S_0, S_1)$, and $(S_0, 0)$. The mean option price for grizzly bear hunting is \$63.75. Mean conditional surpluses range from \$90.00 to \$100.24. In all cases, the calculated 95% confidence intervals fall within $\pm 20\%$ of the respective means. Using the size of the standard error as a measure of 'accuracy', one may conclude that the reported bids are reasonably accurate given the limitations of CV methodology. Cummings et al. (1986) conclude, on the basis of the range of possible error arising from the various sources of bias, that the CVM is unlikely to be more accurate than $\pm 50\%$ of the measured value, given the current state of the art. A reasonable degree of accuracy may have been achieved in this study owing to the adoption of a design which eliminates certain kinds of bias, for example, starting point bias and, to some extent, vehicle bias.

The tests of rationality were carried out in two stages. In the first stage, a nonparametric test was used to ascertain what proportion of the respondents violated the axioms of choice outlined above. In the second stage, difference of means tests were carried out. Both stages of analysis utilized various types of disaggregation. The first set of results are reported in Table III.2. Looking at column 2, it can be seen that of 101 respondents who expressed certain demand, 60% reported $S_1$ bids which were equal to OP, 40% reported $S_1$

**Table III.1 Frequency Distribution of Bids (Demand Uncertainty)**

| $ Value | OP | $(0, S_1)$ | $(S_0, S_1)$ | $(S_0, 0)$ |
|---|---|---|---|---|
| 0 | 26 | 22 | 28 | 23 |
| 1-10 | 45 | 32 | 30 | 29 |
| 11-20 | 40 | 28 | 35 | 35 |
| 21-40 | 21 | 19 | 24 | 13 |
| 41-80 | 50 | 56 | 50 | 52 |
| 81-100 | 42 | 48 | 40 | 46 |
| 101-200 | 12 | 21 | 21 | 19 |
| 201-300 | 4 | 7 | 6 | 6 |
| 301-400 | 1 | 1 | 1 | 4 |
| 401-600 | 1 | 8 | 3 | 11 |
| 601-800 | 0 | 0 | 0 | 1 |
| 801-1000 | 3 | 3 | 3 | 3 |
| Mean | $63.75 | $90.00 | $77.23 | $100.24 |
| Std. Dev. | 114.07 | 145.09 | 132.62 | 157.72 |
| Median | $25.00 | $50.00 | $50.00 | $50.00 |
| 95% C.I. | ±$14.25 | ±$18.17 | ±$16.74 | ±$19.85 |
| N | 246 | 245 | 241 | 242 |

Table III.2 Results of Nonparametric Tests[a,b]

| Test | Certain Demand | Uncertain[c] Demand | Even Prob. Demand | Low Prob. Demand | N[d] |
|---|---|---|---|---|---|
| $S_1 > OP$ | 40<br>(40%) | 59<br>(44%) | 38<br>(44%) | 21<br>(44%) | 99<br>(42%) |
| $S_1 = OP$ | 61<br>(60%) | 67<br>(50%) | 42<br>(48%) | 25<br>(52%) | 128<br>(54%) |
| $S_1 < OP$ | 0<br>(0%) | 9<br>(6%) | 7<br>(8%) | 2<br>(4%) | 9<br>(4%) |
| Z[e] | -5.14* | -6.00* | -4.62* | -4.01* | |
| N | 101 | 135 | 87 | 48 | 236 |

a Statistics exclude respondents who either did not report their demand probabilities or indicated zero future demand.
b Percentages are calculated using column totals.
c Column 3 = column 4 + column 5.
d Column 6 = column 2 + column 3.
e Z-score calculated from Wilcoxon-matched pairs signed-ranks test. The null hypothesis is $S_1 > OP$.
* Significant at the .01 level.

greater than OP and none reported $S_1$ less than OP. These differences are significant at the .01 level, using a Wilcoxon matched pairs signed-ranks test[37].

Among 135 respondents who expressed uncertain demand, 44% reported $S_1$ bids which exceeded OP, 50% had $S_1$ equal to OP and 6% reported $S_1$ less than OP. The H2 requirement is satisfied in this case since only 6% of the total sample reported $S_1$ less than OP. Disaggregating uncertain demanders into those with even (column 4) and low (column 5) probabilities of demand, a trend similar to the above, can be found. Of the 87 respondents with even demand probability, 44% had their $S_1$ bids exceeding OP, 48% had $S_1$ equal to OP and 8% had $S_1$ less than OP. Of the 48 respondents with low probability of demand, 44% had their $S_1$ bids exceeding OP, 52% had $S_1$ equal to OP and 4% had $S_1$ less than OP. The differences between the even and low probability categories are not significant enough to verify the third hypothesis, H3.

Table III.3 presents results of the difference of means tests for hypotheses H1, H2 and H3. It shows that for certain demanders, the mean $S_1$ bid ($113.12) is not significantly different from the mean OP bid ($89.54), $t=1.09$. Thus H1 cannot be rejected at the .01 level, using a two-tailed test. For uncertain demanders, the mean $S_1$ bid ($74.11) exceeds the mean OP bid ($43.11), and this difference is significant, $t=2.40$. Thus the null hypothesis, H2: $(S_1 - OP = 0)$, is rejected in favor of the alternate hypothesis, $S_1 > OP$. Comparing the values column-wise, a rough test of the H3 hypothesis can be carried out. For example, the mean option price bid for certain demanders ($89.54) exceeds that for uncertain demanders ($43.11), and this difference is observed to be significant, $t=3.18$. It may be concluded from the foregoing test results that the data does not reject the assumption of rationality implied by the Expected Utility Model.

Going back to Table III.2, it is important to note that the few cases for which $S_1$ is less than OP fall within the "uncertain" category. One cannot conclude from this that the respondents involved were irrational. It is possible that such seemingly "inconsistent" behavior

[37] See, Hawkins (1980) for a good discussion on this test.

**Table III.3 Results of Difference of Means Tests[a]**

| Category | Mean $S_1$ | Mean OP | t[b] | N |
|---|---|---|---|---|
| Certain Demanders | \$113.12 (157.80) | \$89.54 (148.78) | 1.09[c] | 101 |
| Uncertain Demanders | \$74.11 (132.41) | \$43.11 (68.41) | 2.40[d] | 133 |
| t[e] | 2.05[g] | 3.18[f] | | |

[a] Standard deviations are in parentheses.

[b] The null hypothesis is $S_1 - OP = 0$.

[c] Not significant at the .05 level using a two-tailed test.

[d] Significant at the .05 level using a two-tailed test.

[e] The null hypothesis is $S_1 > OP$.

[f] Significant at the .01 level using a one-tailed test.

[g] Significant at the .05 level using a one-tailed test.

was a result of uncertainty or confusion about the valuation task. This result provides some justification for a recent view of social psychologists that in studies such as this one, respondents must be given an opportunity to resolve the uncertainty through learning (that is, through the process of reevaluating their choices based on their previous experience). Results from the field of experimental economics show that the axioms of the EU model may be satisfied asymptotically after several experimental trials (see, for example, Vickery 1961, Arrow 1982 and Simon 1979). Given the expense of contingent valuation surveys, prospects for multiple contacts with respondents will be severely constrained by low budgets. However, we suggest that when dealing with benefit evaluation involving complicated valuation tasks, respondents should be contacted at least twice (excluding the usual second-mailing).

The second contact should be after initial data analysis. At this stage, additional information would be provided and respondents would be requested to reevaluate their choices[38]. This information could be in the form of a brief summary of other pertinent information, for example, resource and institutional constraints, etc. Such gradual release of information is in recognition of the need for a balance between the individual's need for information in order to make an informed valuation, and their ability to effectively process such information. Multiple follow-ups, such as the above, have been used successfully in studies involving households' perceptions of real risks (eg., see Smith and Desvousges 1988a; 1988b). However, they have hardly ever been used in nonmarket surveys involving demand/supply uncertainty[39].

In view of the intensity of such an approach, not to mention the expense, a reasonable trade-off might be achieved by the meticulous selection of a much smaller representative sample. In a mail survey, a reasonable data set could be obtained if due attention is paid to questionnaire design. However, there is little doubt that the best way of implementing the above procedure is by means of a telephone or face-to-face interview. It is

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[38] This procedure should not be viewed as a form of iterative bidding, whose effectiveness in providing more accurate valuations has been disputed (eg., see Bishop and Heberlein 1988).

[39] Actually, there have been very few studies involving demand/supply uncertainty.

to be noted that there are additional benefits to be reaped by following the suggested procedure. Data could be generated to allow hypothetical biases related to time, information and perceptions to be tested. This could also allow a judgement to be made about the extent to which consumers research their preferences in problem-solving under hypothetical circumstances.

For the balance of this discussion, some issues relating to the methodology employed to elicit benefits under demand uncertainty will be addressed. Though experimental, the methodology could be adapted to value nonmarket environmental commodities under uncertainty. However, there are some serious problems to be confronted. The expected fair-bet point, which yields the maximum expected payment, may be difficult to measure given that many more points on the willingness-to-pay locus are required, as well as more accurate elicitation of demand probabilities. The state-dependent refund schemes designed to elicit conditional consumers' surpluses in this study could prohibit the determination of the fair-bet point. What is at issue is the problem of moral hazard or endogenous probabilities. In short, if people knew that they would be given a refund, they might be tempted to adjust their demand probabilities. In this situation, even meticulous elicitation of probability would not resolve the problem.

The fair-bet point is not necessarily the most theoretically appropriate benefit measure, contrary to the claims of Cory and Saliba (1987). Even if that were the case, Mendelsohn and Strang (1984) have shown why perfectly competitive contingent claims (or insurance) markets are unlikely to exist[40]. In view of the fact that more computational steps are required to measure it, the fair-bet point may not be a pragmatic benefit measure to attempt to evaluate. It would appear that, for now, it will remain as an intuitively appealing theoretical construct. On the other hand, option price, as a practical measure of value under uncertainty, has much to recommend it. It is state independent, and is more easily represented

[40] Other problems (eg., see Mendelsohn and Strang 1984) are adverse selection (assymetric information about the probability of occurrence of states of nature), and complexity of risks (too many states of nature to develop a payment scheme).

to the respondent. Thus, it can be considered a more reliable measure even if it is a "second-best" solution to the valuation problem.

**Supply Uncertainty**

Table III.4 presents results for the frequency distribution, means, standard deviations and 95% confidence intervals for the option price associated with a 90%, 50% and 10% chance of obtaining a grizzly bear hunting license. As in the previous cases, it is seen here that the bid distributions are approximately lognormal. Mean option price for a hunting license is \$45.67, \$31.47 and \$19.55 for 90%, 50% and 10% supply probability, respectively. The calculated 95% confidence intervals fall within a range of ±18% to ±26% of the respective means, indicating a reasonable degree of accuracy in the measurements. Before going on to the first test of rationality in this section, it is important to note from Table III.4 that as supply uncertainty increases, the frequency of cases in the lower dollar categories (\$0 and \$1-10) increases. Thus, people are unwilling to pay more as their chances of obtaining a license declines, which is an indication of rational behavior.

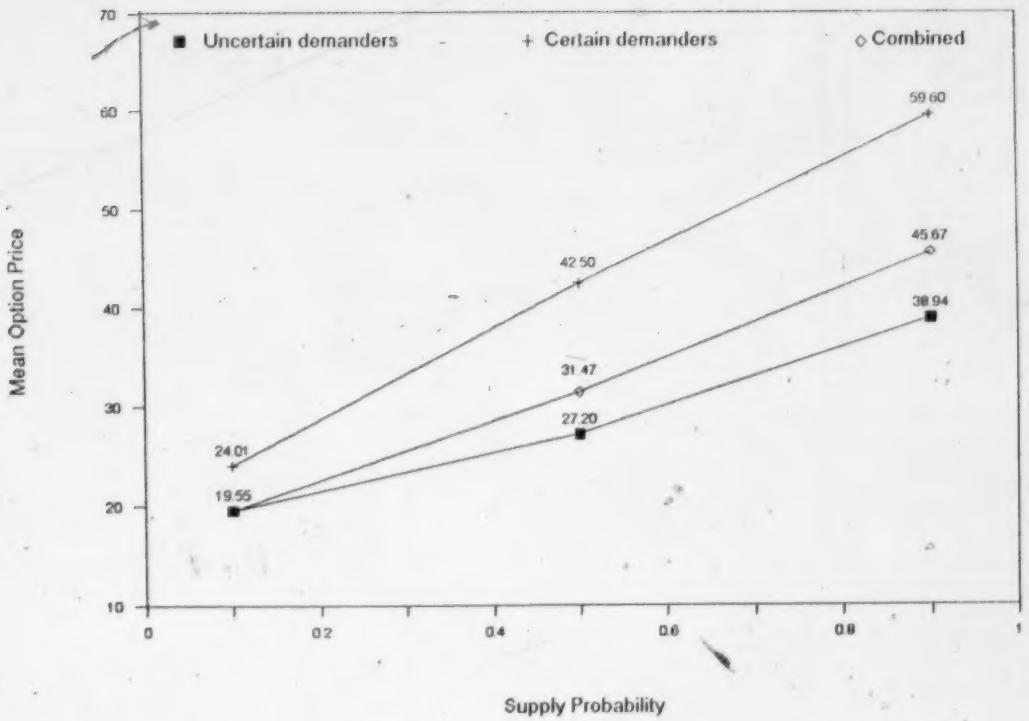
The test of H4 was carried out using data from Figure III.2. The graph shows that, as hypothesized, option price is an increasing function of the probability of supply. Examining in more detail the plot for the complete sample (see middle graph), it is seen that the mean option price for $\pi_2$ = .90, \$45.67, is significantly greater than that for $\pi_2$ = .50, \$31.47 (t=2.60). Furthermore, mean option price for $\pi_2$ = .50 is significantly greater than for $\pi_2$ = .10, \$19.55 (t=2.75). Thus, the null hypothesis, H4, cannot be rejected.

Disaggregating the sample into certain and uncertain demanders, it can be seen that at $\pi_2$ = .90, mean option price for certain demanders (\$59.60) is significantly greater than for uncertain demanders (\$38.94), t=2.43. At $\pi_2$ = .50, the mean option price for certain demanders (\$42.50) is also significantly greater than for uncertain demanders (\$32.80), t=2.09. Finally, at $\pi_2$ = .10, mean option price for certain demanders (\$24.01) is greater than that of uncertain demanders (\$19.51), however, this difference is not significant

**Table III.4 Frequency Distribution of Bids (Supply Uncertainty)**

| $ Value | OP(90%) | OP(50%) | OP(10%) |
|---|---|---|---|
| 0 | 41 | 45 | 72 |
| 1-10 | 26 | 40 | 58 |
| 11-20 | 30 | 32 | 20 |
| 21-40 | 20 | 30 | 19 |
| 41-80 | 45 | 31 | 20 |
| 81-100 | 32 | 19 | 8 |
| 101-200 | 6 | 3 | 1 |
| 201-300 | 1 | 1 | 2 |
| 301-400 | 1 | 0 | 0 |
| 401-500 | 1 | 1 | 0 |
| Mean | $45.67 | $31.47 | $19.55 |
| Std. Dev. | 60.86 | 48.19 | 37.89 |
| 95% C.I. | ±$8.37 | ±$6.66 | ±$5.25 |
| N | 203 | 201 | 200 |

**Figure III.2 The Relationship between Option Price and Supply Uncertainty**



(t=0.75). Nevertheless, H5 cannot be rejected on the strength of the overall results.

The only previous empirical study of supply uncertainty in North America was by Brookshire et al. (1983) on grizzly bear and bighorn sheep hunters in Wyoming. Comparing the above results to that study, some interesting differences and similarities can be drawn. In contrast to the Brookshire et al. study, bids for certain hunters in this study consistently exceed those of uncertain hunters, which is what theory would predict. Perhaps, this difference is due to the fact that respondents in that study were required to provide bids at four levels of supply probability (25%-90%) and for two future time periods (5 and 15 years). Since that study was based on a one-time survey, such a design could have introduced more uncertainty or difficulty into the valuation task. It is important to note, however, that there are some similarities in the pattern of bids observed in both studies. The combined results on Figure III.2 indicate that, on average, respondents were risk neutral. However, respondents who were less than certain about future demand tended to gamble (i.e. take risks), judging by the concavity of the bottom graph (see Figure III.2). This corresponds to Brookshire et al's findings for uncertain hunters. However, unlike Brookshire et al., we do not think such results are unexpected. Estimated mean option price is not much greater than 0.1% of mean income, therefore it is not surprising that there is a weak tendency towards risk aversion on the part of uncertain demanders.

A probit model was estimated to determine whether there were any socioeconomic differences between certain and uncertain demanders. The results are reported in column 2 of Table III.5. They show that the significant differences are in regard to income and age. Respondents who are uncertain about future demand tend to be those with relatively lower incomes who are probably also uncertain about (or do not expect) higher future incomes. This line of reasoning is supported by the observation that people who are uncertain tend to be relatively older. Such people also show a shorter time horizon of expected hunting.

The final analysis of option price bids involved fitting bid functions for the various levels of supply probability using the following variables: expected hunting years (YEARS);

**Table III.5 Results of Probit Analysis and Bid Estimations[a]**

| VARIABLE | PROBIT[b] | OP(90%)[c] | OP(50%)[c] | OP(10%)[c] |
|---|---|---|---|---|
| CONSTANT | 0.1491 | 3.1708 | 2.7637 | 2.4495 |
| | (0.3541) | (6.0136)••• | (5.5076)••• | (4.6609)••• |
| YEARS | 0.0006 | 0.0058 | 0.0059 | 0.0055 |
| | (0.0551) | (1.6593)•• | (1.7945)•• | (1.5839)• |
| PROB | - | 0.2513 | 0.2873 | 0.1900 |
| | | (2.0641)•• | (2.4797)••• | (1.5657)••• |
| EDUC | -0.0189 | 0.0266 | 0.0276 | 0.0239 |
| | (-0.6587) | (0.7522) | (0.8190) | (0.6774) |
| INC | 0.0097 | 0.0122 | 0.0075 | -0.0035 |
| | (1.9593)•• | (2.0330)•• | (1.3126)• | (-0.5846) |
| AGE | -0.0134 | -0.4054 | -0.0349 | -0.0301 |
| | (-1.7966)• | (-4.6995)••• | (-4.2552)••• | (-3.5042)••• |
| $R^2$ | 0.0458[d] | 0.1593 | 0.1448 | 0.0960 |
| LRT[e] | 6.91 | - | - | |
| F | - | 7.32•• | 6.53••• | 4.10 |
| N | 199 | 199 | 199 | 199 |

[a] t-ratios are in parentheses.
[b] The dependent variable is Prob.(C > 0), where C=1,0 represents certain and uncertain demand, respectively.
[c] The dependent variable is in log form.
[d] Cragg-Uhler $R^2$.
[e] LRT is likelihood ratio test, distributed $x^2$ with 4 degrees of freedom.
••• Significant at the .01 level using a one-tailed test.
•• Significant at the .05 level using a one-tailed test.
• Significant at the .10 level using a one-tailed test.

probability of demand (PROB); years of education (EDUC); income (INC) and AGE. The results are shown in columns 3 to 5 of Table III.5. It is seen here that, as in the probit model, the important factors affecting option price are income and age. Income is positively related to option price, as expected from theory, while age shows a negative relationship. Other important determinants are the expected time horizon of hunting and probability of demand, which have the expected positive signs and are significant at all three levels of supply probability. The level of education does not appear to be significant in all three models.

The results of these bid regressions reinforce the earlier conclusions that the estimated bids are consistent with theory. However, the low explanatory power of the models are indicative of the fact that other important independent variables that impinge on the problem of uncertainty may have been omitted. These are likely to be noneconomic and social/psychological factors such as perceptions and all kinds of expectations. Further research is therefore required to explain the role of such variables in the determination of nonmarket values given uncertainty[41].

**E. Summary and Implications**

This study has attempted to make a contribution to the resource economics literature in two areas which are currently at the forefront of research on nonmarket valuation of environmental commodities, namely, benefit estimation under conditions of demand and supply uncertainty. It has tested a methodology which might be used to estimate such a measure. At the same time, it points out the empirical pitfalls inherent in attempting to use state-dependent contingent payment schemes as a means of measuring the fair-bet point. For example, the problem of moral hazard was noted as a major obstacle. Perhaps, this problem could be alleviated by devising contingent payment schemes involving some kind of penalty factor. However, further research is required to investigate the problem.

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[41] A qualitative variable for attitude towards wildlife was tested earlier on but was found to be uncorrelated with option price.

There is presently much confusion in the literature about what is an appropriate measure of benefits under uncertainty. It has been suggested (eg., see Schmalensee 1975) that perhaps the uncertainty problem could be solved by projecting future use patterns from past use (see also, McConnell 1985). This is equivalent to using expected consumer's surplus as a measure of benefits under uncertainty. Theory suggests that would be inappropriate in view of the indeterminacy of the sign of option value. There has also been debate about which of the two measures - option price or the fair-bet point - is more appropriate to use. (eg., see Cory and Saliba (1987). One justification for the fair-bet point is its dependence on an equamarginal principle which allows individuals to optimally redistribute risk between states of nature. It is thus clear that the fair-bet point would be appropriate only if, say, government or some other public agent would provide a suitable contingent market which would offer individuals the opportunity to redistribute risk by making state-dependent payments.

Given the theoretical and practical problems outlined in this study, it can be concluded that option price is a more pragmatic, and at present, a more reliable measure of benefits under uncertainty. There is an added advantage in using option price: it includes option value, regardless of its sign. Thus, there is no need for adjustments to take account of the size and/or sign of option value.

In the area of supply uncertainty, this study has attempted to improve on Brookshire et al's (1983) pioneering effort. In that study, the authors failed to generate theoretically consistent results and were unable to explain perceived anomalies. Consequently they were led to express a guarded optimism for the use of contingent markets in measuring benefits under uncertainty. The methodology applied in this study results in value estimates which are consistent with the predictions of theory. The results also give a clearer picture of factors influencing an option price bid. In particular, it has been shown that the individual's time horizon for use and probability of demand significantly affect the magnitude of option price. Until market-related approaches are fully developed to handle uncertainty, CV surveys remain the only line attack. In this respect, the results reported here must be considered encouraging

as far as the validity and accuracy of the method is concerned. It was noted, however, that there is a great deal of room for improvement. In particular, further research is required to incorporate noneconomic and psychological variables which could be important in the problem of uncertainty.

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## IV. Towards the Measurement of Total Economic Value: The Case of Wildlife in Alberta

### A. Introduction

The word 'value' is a label used to describe what an individual or society considers preferable or desirable[42]. The constituents of value have remained elusive despite having engaged the attention and efforts of philosophers for centuries. In the economics discipline, the concept of value is central to the notion of rational choice. For example, in Benefit-Cost Analysis, the value of social benefits of a proposed policy or program are typically compared to the social costs in order to determine whether there is a net gain to society. The policy is judged to be preferable if there is a positive net gain. As far as possible, social benefits and costs are measured in monetary terms. The Benefit-Cost approach presumes accurate knowledge of the value of resources involved in the decison problem. Resource economists have long recognised problems associated with attempts to apply the Benefit-Cost criterion to decisions involving natural resource commodities and services (eg., recreational use of wildlife). Such commodities are not normally traded in competitive markets and as such their values are not accurately reflected by market prices.

Initially, economists attempted to deal with the problem by lumping such 'unpriced' items into one category called "intangibles" or "unmeasurables" (see, for example, Eckstein 1958; Henderson 1970; Gittinger 1972; Smith 1976). The following was a popular prescription for the problem of intangibles:

> **".....the best practice seems to be to acknowledge that intangible effects exist and are important but not to attempt to value them or include them in the economic analysis computations." (Gittinger 1972, pp. 30)**

Following prescriptions such as the above tends to result in public resource allocation decisions in which the contribution of nonmarket natural resource commodities to social

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[42] Value also has nonpreference dimensions. An example is functional value (Andrews and Waites 1978), which strictly concerns the biological or physical relationships of one nonhuman entity to another (eg., the value of water to, say, waterfowl habitat).

benefits is not fully accounted for. Within the last two decades, however, significant progress has been made in developing techniques to enable economic values to be assigned to so-called intangibles. Examples are the Travel Cost Method (TCM), which utilizes travel expenditures to infer value; the Hedonic Price Method (HPM), which utilizes recreational-related market expenditures to infer value; and the Contingent Valuation Method (CVM), which utilizes interviews or mail surveys to ask people about the economic value they place on a given resource. In spite of the fact that people in both the academic and resource management communities have come to accord these methods reasonable levels of acceptability, the issue of valuing intangibles remains far from being resolved.

One shortcoming of empirical applications of the above techniques is that they have focused almost exclusively on use (or site) values. However, nonuse values, alluded to by Weisbrod (1964) and Krutilla (1967), would appear to be significant in certain cases. For example, Schulze et al. (1983) found estimates of preservation values for visibility at the Grand Canyon (United States) to be between $34 and $52 per household per year, of which less than 0.5% was directly attributable to user values[43]. Meyer (1978) estimated preservation values for salmon in the Fraser River in British Columbia to be $223 per household per year. Mitchell and Carson (1981) estimated intrinsic (nonuse) values for U.S freshwater rivers, lakes and streams to be $111 per household per year.

Greenley et al. (1981) found existence values for preserving water quality in the South Platte River in Colorado to be about 53% of use value. Other empirical estimates of nonuse value include Brookshire et al. (1983) who found preservation values of grizzly bear and bighorn sheep habitat in Wyoming to be $24.00 and $7.40, respectively, for a given five-year time horizon. When appropriately aggregated over all households in the relevant populations, these values amount to millions of dollars for a given resource/environmental commodity.

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[43] For less well-known and non-unique natural environments in the U.S., nonuse values have been found to be 40-50% of estimated user values (Fisher and Raucher 1984).

The measurement of nonuse values is thus emerging as one of the frontiers of current research in nonmarket value estimation. The following agenda (eg., see Smith 1987a, 1987b; Randall 1987; Madariaga and McConnell 1987) has been proposed for future research; (i) the development of a consistent taxonomy of value measures among economists; (ii) the development of a theory of nonuse value which is compatible with current neoclassical economic thought;[44] (iii) the development of appropriate methods of measurement; and (iv) the investigation of the effects of uncertainty and motives on nonuse values.

The purpose of this study is to provide an empirical estimate of the total economic value of wildlife resources in Alberta. It seeks to extend previous research efforts (eg., see Phillips et al. 1978, Wilson 1983; Adamowicz 1983, Jacquemot et al. 1987) by incorporating the nonuse element into the valuation process. In pursuing this objective, the study also attempts to address some of the research issues outlined above.

The remainder of this chapter is organised as follows: section two develops a comprehensive taxonomy of economic value, beginning from a philosophical perspective. An attempt is made to reconcile apparent differences in terminology employed in previous studies. Section three introduces a neoclassical model of consumer choice which accounts for both use and nonuse values. The fourth section presents the experimental design used to elicit economic values outlined in the theoretical section. The empirical results are contained in the penultimate section. A discussion of the socioeconomic characteristics, hunting activity and economic values arising from consumptive and nonconsumptive use of wildlife is included. The final section presents the summary and implications.

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[44] At present, nonuse values appear to conflict with conventional economic wisdom because they suggest that utility can be achieved regardless of consumption. Brookshire et al. (1987) have suggested that not all values individuals hold can be described as an economic value, especially if such values are based on ethical considerations.

**A Taxonomy of Value Measures**

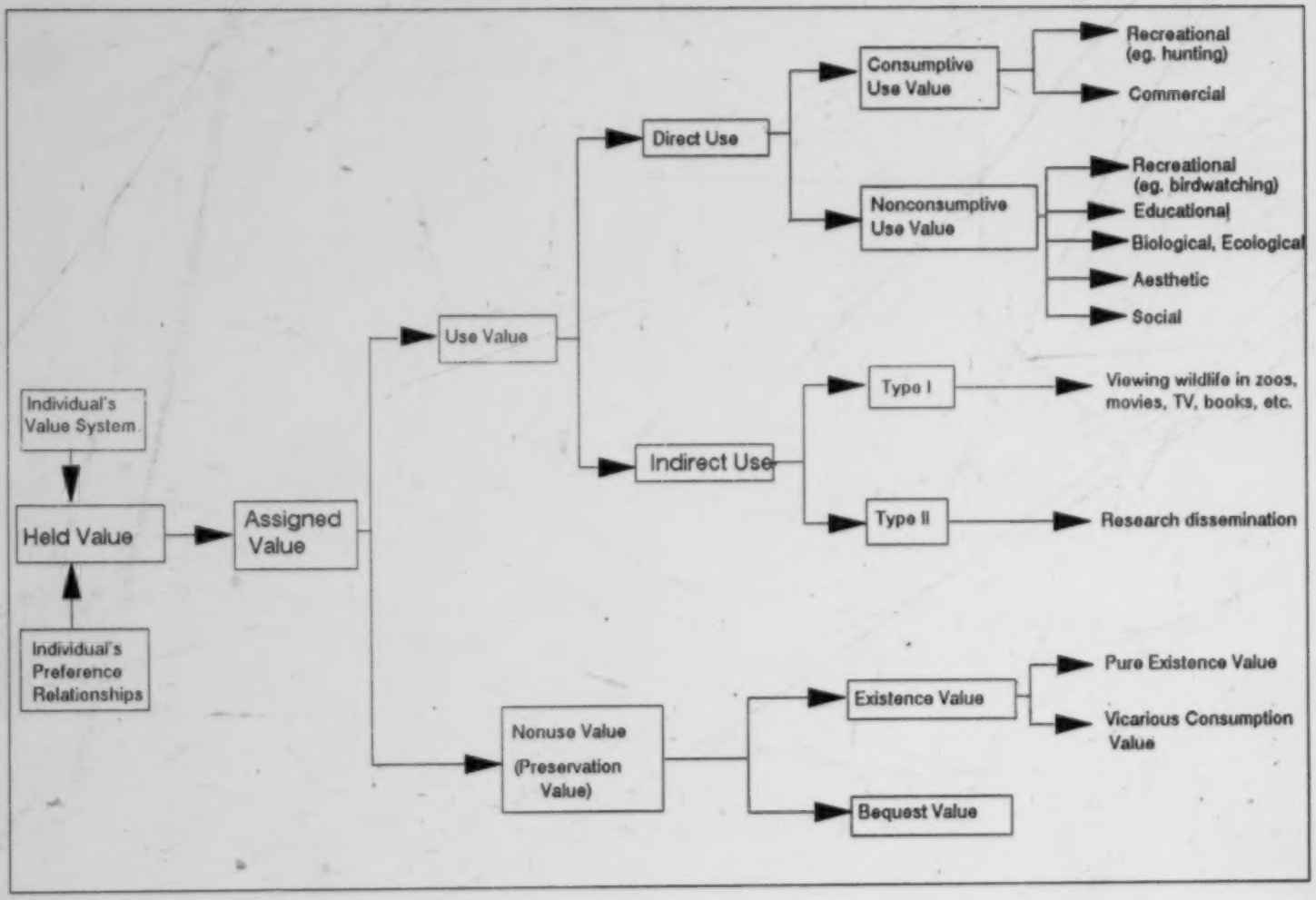
An individual's value system consists of what has variously been described as "held values", "underlying values", or "values proper" (Brown, 1984, Rokeach 1973, Rescher 1969). Held value, in itself, is not an observable entity. However, based on the individual's preference relationships, held value can be measured via assigned value. The latter can be measured by means of suitable indicators. Economic value, which is expressed through monetary measures, is thus a special class of assigned value[45]. It is important to note that assigned value is a relative (and not an absolute) concept, determined from the relative importance of a given resource or commodity. Figure IV.1 shows a schematic representation of the various constituents of assigned value. Assigned value can be broadly categorized into use value and nonuse value.

Use value is also further divided into two components: direct value and indirect value. An individual derives direct value by coming into contact (or interacting) with the resource or commodity. However value is also derived indirectly through means such as viewing wildlife in zoos, movies, TV documentaries, books, etc., or discovering results of wildlife-related research disseminated in books and other publications. Direct use has two subcomponents: consumptive use and nonconsumptive use. Consumptive use (eg., recreational or commercial hunting of wildlife) results in the resource being depleted, while nonconsumptive use involves on-site use which may not result in resource depletion. Examples of nonconsumptive use are recreational uses such as viewing or photographing wildlife; educational uses such as studying wildlife; aesthetic uses such as admiring scenery, etc.

In addition to use value, an individual may have nonuse value which exists outside of any intentions pertaining to future or current use. This is referred to as ***preservation value***. Preservation value has two major components: ***existence value*** and ***bequest value***. Existence value results from the satisfaction the individual derives from knowing that the resource simply exists. There are at least two subcomponents of existence value: vicarious consumption

[45] See Brown (1984) for a more detailed discussion of the philosophical basis of value.

**Figure IV.1 A Taxonomy of Value Measures**



value and pure existence value. Vicarious consumption value results from the individual's satisfaction in knowing that another individual is using or will use the resource in question. Vicarious consumption may therefore be viewed as some kind of interpersonal altruism (eg., see Randall 1987; Randall and Stoll 1983). Existence value is, however, not entirely derived from altruistic motives. For example, an individual may have willingness-to-pay for preservation of the grizzly bear merely out of sympathy for that species. This is referred to as pure existence value. Bequest value is defined as an individual's willingness-to-pay for the preservation of a given resource so that their offspring will have the opportunity of using it in the future. Thus bequest value may be considered a form of intergenerational altruism.

Nonuse values have been characterised in forms other than those described above. Notable examples are "altruism" (Randall and Stoll 1983); "stewardship" and "intrinsic value" (Fisher and Raucher 1984). Since altruism is simply a concern for the welfare of others, it may be included in the definition of bequest value (i.e., intergenerational altruism) and/or vicarious consumption (i.e., interpersonal altruism). Fisher and Raucher (1984) define stewardship as an individual's willingness-to-pay for preservation of natural environments as a means of preserving ecological diversity. If one assumes that ecological diversity is beneficial to society, then stewardship may be included in the above discussion as a form of existence value (vicarious consumption). Fisher and Raucher (1984) also define intrinsic value as the sum of option value, existence value and bequest value. This would appear to be consistent with our definition of preservation value.

The foregoing taxonomy challenges the conventional notion in economics that motives do not matter. It is well known that certain individuals derive utility (or disutility) from the preservation (or development) of certain natural resources and the environment. The willingness of individuals to pay nontrivial amounts of money for the preservation of natural resources which they may never hope to personally profit from, is evidence of the fact that motives (whether altruistic or intrinsic) do matter. In the following section, a model of consumer choice which explicitly incorporates use and nonuse (preservation) values as

arguments in the choice problem is presented.

**B. Theoretical Model**

To simplify the analysis, it is assumed that the consumer makes choices under conditions of near certainty. That is, values which individuals may have as a result of uncertainty about future use (option value) are excluded. It is also assumed that the consumer has a utility function which is well-behaved. That is, it has desirable properties such as being twice differentiable, quasi-concave, etc. (Varian 1984). Define the consumer's choice problem as follows:

$$\max U(x_1, x_2, x_3, x_4, Z, R) \tag{1}$$

subject to:

$$\sum_{i=1}^{4} P_i x_i + P_Z Z \leq Y \tag{2}$$

$$x_i \geq 0 \tag{3}$$

$$Z \geq 0 \tag{4}$$

$$R \geq 0 \tag{5}$$

where $x_1$ is direct consumptive use (eg., hunting); $x_2$ is direct nonconsumptive use (eg., watching, feeding, photographing or studying wildlife); $x_3$ is indirect use (eg., reading about wildlife or viewing a TV program on wildlife); $x_4$ is nonuse; Z is a vector of market commodities; R is a nonmarket resource (eg., grizzly bear); $P_i$ is a vector of prices reflecting the various categories of use and nonuse; $P_Z$ is a vector of market prices; and Y is household income.

It has been suggested that, using the principle of weak complementarity between Z and R (Maler 1974), use and nonuse values may be derived from the expenditure function (Smith 1987a, 1987b; Madariaga and McConnell 1987). Although theoretically appealing, this approach is critically dependent on the existence of market-related goods complementary to the nonmarket good. However, in reality, certain types of value (eg., pure existence value) may not be connected with any other good. Thus it is possible that the above approach may

never be used for several kinds of nonmarket natural resources. The approach adopted below uses the contingent valuation method to obtain compensating surplus measures for both use and nonuse (preservation) value.

Define the indirect utility function as follows:

$$V(P_1, P_2, P_3, P_4, R, Y) = U(\bar{x}_1, \bar{x}_2, \bar{x}_3, \bar{x}_4, R) = \bar{U} \qquad (6)$$

where $\bar{x}_i$ denotes the optimal level of the choice variable $x_i$ ($i = 1 - 4$), obtained by solving equations (1) to (5). Consumptive use value can be defined in terms of the Hicksian compensating surplus corresponding to a price change from the existing price to the choke price (i.e. the price at which none of the resource will be demanded). That is,

$$V(P_1, P_2, P_3, P_4, R, Y - UV) = V(P_1^*, P_2, P_3, P_4, R, Y) \qquad (7)$$

where $P_1^*$ is the choke price and UV is willingness-to-pay to hunt wildlife. Similarly, the compensating surplus measure for the preservation of wildlife can be defined as:

$$V(P_1, P_2, P_3, P_4, R, Y - PV) = V(P_1, P_2, P_3, P_4, 0, Y) \qquad (8)$$

where PV is willingness-to-pay to preserve wildlife.

**C. Experimental Design**

The following is a brief description of the experimental design used to obtain empirical estimates of use and nonuse (preservation) values. A random sample of 2,590 hunters who purchased hunting licenses during the 1987/88 season was utilized in this study. The sampling frame was obtained from the computer files of Alberta Forestry, Lands and Wildlife (Fish and Wildlife Division). The response rate, after two mailings and adjusting for undelivered questionnaires, was approximately 51%.

The Contingent Valuation Method is well suited for obtaining the empirical estimates of the Hicksian surplus measures defined in section IV.B. Unlike the Hedonic Price Method or the Travel Cost Method, CVM does not require estimation of demand functions and does not make assumptions about individual preferences. In this study, the Hicksian surplus measures are given practical interpretation as an individual's maximum willingness-to-pay for an

increase in the level of supply of the commodity. Thus, use value (UV) of big game, as defined by equation (7), was elicited as follows:

> **"How much would you be willing to pay (above what you spent on travel and other expenses) to hunt big game in Alberta in 1987/88? (Please circle the appropriate dollar value)."**

Use value for grizzly bear was also elicited in similar fashion. Preservation value (PV), equation (8), was elicited as follows:

> **"The following questions are intended to give an indication of how you value the preservation of wildlife in Alberta. Suppose a public trust fund were set up to preserve wildlife in Alberta.**
>
> **a. What is the MAXIMUM amount of money you would be willing to donate annually to the fund for the preservation of wildlife? (Please circle the appropriate dollar value)."**

A similar question was posed for the situation where the trust fund would be used solely for the preservation of the grizzly bear. The willingness-to-pay question format for both use and preservation included a modified version of Mitchell and Carson's (1981) payment card, consisting of an array of dollar values ranging from $0 to $900. Space was provided for values in excess of $900. Additional data obtained for this study were respondents' attitudes towards wildlife and the following socioeconomic characteristics; place of residence, age, sex, education, family size and family income. The full-length questionnaires can be found in the Appendix.

## D. Empirical Results and Discussion

### Socioeconomic Characteristics

Table IV.1 compares the characteristics of the sample and the general population. There are approximately 2.4m residents in the province of Alberta of whjch 140,579 (7.0%) are registered hunters. The mean age of hunters is 38.0 years, while that of the general population is 39.0 years. Slightly over half (52.9%) of the population of hunters reside in

**Table IV.1 Socioeconomic Characteristics of Hunters and the General Population**

| Variable | Hunters | General Population[a] |
|---|---|---|
| Population Size | 140,579[b] | 2,365,825 |
| Mean Age in Years | 38.0 | 39.0[c] |
| Residence: | | |
| % Resident in Urban Areas | 47.1 | 79.4 |
| % Resident in Rural Areas | 52.9 | 20.6 |
| Sex: | | |
| % Male | 96.4 | 50.4 |
| % Female | 3.5 | 49.6 |
| Educational Level: | | |
| Grade/High School | 65% | 52% |
| Post-Secondary[d] | 35% | 48% |
| Mean Household Size (Persons) | 3.2 | 3.2 |
| Mean Household Income | $39,320 | $36,796 |

[a] Figures refer to the Province of Alberta. Source: Statistics Canada (1988).
[b] Source: Alberta Forestry, Lands and Wildlife (1988).
[c] Includes persons over 15 years.
[d] Includes persons with university, college, technical or trade school education.

rural areas, wheras only one-fifth (20.6%) of the general population reside in rural areas. Approximately half of general population (49.6%) are female while only 3.5% of hunters are female. Approximately half (48%) of the general population have some form of post-secondary education (i.e., university, college, technical or trade school), whereas only 35% of hunters have similar educational background. The mean household size of both the hunter and general population is 3.2 persons. The mean household income of hunters is $39,320 per annum, while that of the general population is $36,796 per annum. Given a household size of 3.2 persons, the annual per capita income of hunters is slightly higher at $12,288 compared to $11,500 for the general population.

To summarize the socioeconomic characteristics, the typical hunter in Alberta is 38 years of age, has a high school education, is a member of a family of three to four persons, receives a family income of $39,320 per annum, and tends to be a rural male.

**Hunting Activity**

Respondents who hunted during the 1987/88 season were requested to provide an account of their hunting activities. Table IV.2 presents a summary of the information gathered. On average, each hunter made 2.73 trips in the season, hunted for 13.71 days, spending 5.02 days per trip. Each hunter travelled an average distance of 564.96 km (one way) to his hunting site and harvested an average of 5.82 wildlife in the season. Of the 1303 persons who hunted in 1987/88, 924 or 71% hunted big game species in 1987/88. Each big game hunter took an average of 2.98 trips in the season, lasting an average of 13.14 days and 4.41 days per trip. Also, each big game hunter travelled an average of 528.61 km (one way) to his hunting site and harvested 1.19 wildlife in the season.

Forty-five (4%) persons in the sample sought grizzly bear. Each grizzly bear hunter took an average of 1.56 trips during the season, hunted for an average of 8.05 days, spending an average of 5.16 days per trip. Each grizzly bear hunter travelled an average of 467.05 km (one-way) to the hunting site, and harvested an average of 0.38 animals in the season.

Table IV.2 Hunting Activities of Resident Hunters, 1987/88 Season

| Variable | All Hunting | Big Game Hunting | Grizzly Bear Hunting |
|---|---|---|---|
| Population Size[a] | 140,579 | 77,717 | 1,068 |
| Sample Size (% Population) | 1,303 (1.0%) | 924 (1.0%) | 45 (23%) |
| No. of Trips/Person | 2.73 | 2.98 | 1.56 |
| Total Days Hunted/Person | 13.71 | 13.14 | 8.05 |
| Days Hunted/Trip/Person | 5.02 | 4.41 | 5.16 |
| Distance Travelled One Way (Km) | 564.96 | 528.61 | 467.05 |
| No. of Wildlife Taken/Person | 5.82 | 1.19 | 0.38 |

[a] Source: Alberta Forestry, Lands and Wildlife (1988).

Information obtained from the study also indicates that in 1987/88, 42% of all hunters took trips specifically for nonconsumptive purposes. This suggests that nonconsumptive recreational activity was also significant.

**Analysis of the Total Economic Value of Wildlife Resources**

Prior to calculating the total economic value of wildlife resources, bid functions were fitted to the data to ascertain whether the estimated bids accord with theoretical and *a priori* expectations. It was hypothesized that income would be positively related to willingness-to-pay to use and to preserve wildlife. It was also postulated that, on average, persons who took trips for nonconsumptive purposes would have a higher value for wildlife than those who did not. Thus, willingness-to-pay to preserve wildlife for the former would be greater than for the latter.

Four bid functions were estimated for use and preservation value of big game, and for use and preservation value of grizzly bear. Table IV.3 reports the results of these estimations. Attitude towards wildlife was found to be an insignificant determinant of willingness-to-pay and was thus omitted from the final estimating equations[46]. Generally speaking, the bid functions have low explanatory power as can be seen from the the low $R^2$'s. On the other hand, it is important to note that all the regressions are significant at the 1% level, judging from the high F-statistics. As expected from theory, there is a strong positive income effect on use and on preservation (nonuse) value. There is also an expected positive and significant relationship between use value and annual hunting expenditure. It can be seen that, as hypothesized above, persons who took nonconsumptive trips (see TRIP coefficients) expressed higher preservation values than those who did not. Age is particularly significant in the equations for preservation value and has a negative sign in both cases. It is conjectured that this result may be a general indication of the increasing awareness of young people today

[46] This result can be explained from the fact that there was not much variation in responses to the attitude question, with almost everyone ranking wildlife as being of high value.

Table IV.3 OLS Estimation of Bid Functions[a]

| Variable | UV(big game)[b] | UV(griz. bear)[b,d] | PV(big game)[c,d] | PV(griz. bear)[c,d] |
|---|---|---|---|---|
| Constant | 27.731 | 3.2472 | 3.4391 | 3.4182 |
| | (0.6429) | (11.013)*** | (19.651)*** | (17.050)*** |
| AGE | 0.9291 | -0.0305 | -0.0136 | -0.0305 |
| | (1.0705) | (-5.0600)*** | (-4.1690)*** | (-7.8655)*** |
| EXP[e] | 0.1351 | 0.0005 | - | |
| | (8.2511)*** | (4.9713)*** | | |
| INC | 1.5727 | 0.0105 | 0.0163 | 0.0125 |
| | (2.7412)*** | (2.6962)*** | (7.5122)*** | (5.0199)*** |
| TRIP[f] | - | - | -0.1462 | -0.1413 |
| | | | (-2.4046)*** | (-2.0475)** |
| $R^2$ | 0.0806 | 0.0656 | 0.0664 | 0.0776 |
| F | 27.86*** | 21.59*** | 27.63*** | 31.57*** |
| N | 958 | 927 | 1169 | 1130 |

[a] Standard errors are in parentheses.
[b] UV is annual willingness-to-pay to hunt.
[c] PV is annual preservation value.
[d] The dependent variable is in log form.
[e] EXP represents hunting expenditure.
[f] TRIP represents trips taken exclusively for nonconsumptive (i.e., nonhunting) purposes; 1=took a trip, 0=did not take a trip.
*** Significant at the .01 level for a one-tailed test.
** Significant at the .05 level for a one-tailed test.
* Significant at the .10 level for a one-tailed test.

about environmental issues, viz. wildlife preservation.

The final set of results concern the determination of aggregate annual and present values for wildlife resources. In view of the skewness in the bid distributions (see Appendix), aggregate values were computed using means and medians. Adopting the mean or median has different implications for aggregation and provision of the given public good. If individual preferences are identical, both measures should result in identical WTP (or WTAC) estimates. However, decisions based solely on the mean could be misleading where a minority of people have a high value for the given public good. The use of the median is consistent with a majority voting or referendum model. In this case, large numbers of people (up to 50% in a simple majority rule) may not necessarily exert influence on the provision of the good[47]. Thus, for policy purposes, it is useful to display both sets of measures. Annual aggregate values were calculated as follows:

$$\sum_{j=1}^{N} (WTP_j) \qquad (9)$$

where N is the relevant population of hunters in the province and $WTP_j$ is the mean (or median) willingness-to-pay of the $j^{th}$ hunter.

Table IV.4 presents results for the means, medians, standard deviations and 95% confidence intervals for use and preservation values of big game and grizzly bear, respectively. The mean value for big game hunting is $204.06 per person per annum[48], while the mean preservation value for big game is $70.70 per person per annum. Summing the two values, we arrive at a figure of $274.76 for the total annual per capita economic value of big game resources. Annual use and preservation values, using the median, are $100.00 and $50.00, respectively, for big game. This results in a total economic value of $150.00 per person per annum.

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[47] The mean is consistent with a private goods market model. See Denzau and Parks 1983, Zeckhauser 1973, and Romer and Rosenthal 1978 for a discussion of voting models.

[48] This figure compares favorably with Jacquemot et al's (1987) mean WTP of $267.15 per annum for large mammal hunting in Canada.

**Table IV.4 Mean Annual Use and Preservation Values**

| Value Category | Big Game ($/Person/Year) | $n_1$ | Grizzly Bear ($/Person/Year) | $n_2$ |
|---|---|---|---|---|
| Use Value: | | | | |
| Mean | $204.06 | 961 | $151.12 | 931 |
| Std. Dev. | (379.82) | | (392.05) | |
| 95% C.I. | ±$24.01 | | ±$25.18 | |
| Median | $100.00 | | $40.00 | |
| Preservation Value: | | | | |
| Mean | $70.70 | 1176 | $45.25 | 1134 |
| Std. Dev. | (121.03) | | (90.13) | |
| 95% C.I. | ±$6.92 | | ±$5.25 | |
| Median | $50.00 | | $20.00 | |
| Total Economic Value: | | | | |
| Mean | $274.76 | | $193.37 | |
| Median | $150.00 | | $60.00 | |

Mean annual use and nonuse values for grizzly bear are $151.12 and $45.25 per person, respectively, resulting in annual total economic value of $193.37 per person. Corresponding median use and preservation values for grizzly bear are $40.00 and $20.00, respectively, giving a total of $60.00 per person per annum. It can be seen from Table IV.4 that the calculated 95% confidence intervals fall within 12-16% of the mean for use values, and within 6-10% of the mean for preservation values. Furthermore, in most cases, the medians fall within 40-50% of the respective means[49]. These results suggest that the individual estimates are of reasonable accuracy.

Table IV.5 presents aggregate annual and present values for the economic benefits of recreational hunting. Annual aggregate values for big game and grizzly bear were obtained by summing the total value per person over the respective potential population of hunters[50]. It can be seen that the total economic value of big game to hunters in 1987/88 were over $21 million, aggregating via the mean. The total economic value of the grizzly bear to hunters was in excess of $200,000. Aggregating via the median, total values of big game and grizzly bear were $11,657,550 and $64,080, respectively. Present values were calculated at discount rates of 5% and 8% in perpetuity. The results show that the total economic value of big game species exceed $427 million and $266 million using 5% and 8% discount rates, respectively, and aggregating via the mean. On the other hand, corresponding values using the median are over $233 million and $145 million respectively. Present values for grizzly bear are over $4 million and $2 million for 5% and 8% discount rates, respectively, aggregating via the mean. Finally, corresponding grizzly bear values using the median are $1,281,600 and $801,000, respectively.

Two major conclusions can be drawn from the foregoing results. First, they show that benefits derived from wildlife resources in Alberta are fairly substantial. Second, nonuse values account for a fairly significant portion of the total value of wildlife resources. For example, ignoring nonuse values in public policy analysis could result in underestimation of

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[49] Grizzly bear use values have the most variability, with the median falling within 73% of the mean.

[50] The actual number of big game hunters is difficult to obtain since hunters typically purchase different combinations of hunting permits.

**Table IV.5 Aggregate Annual and Present Values[a,b]**

| Value Category | Big Game | Grizzly Bear |
|---|---|---|
| Population Size[c] | 77,717 | 1,068 |
| Annual Value | | |
| Based on Mean | $21,353,522 | $206,519 |
| Based on Median | $11,657,550 | $64,080 |
| Present Value (5% d.f.)[d] | | |
| Based on Mean | $427,070,440 | $4,130,383 |
| Based on Median | $233,151,000 | $1,281,600 |
| Present Value (8% d.f.)[d] | | |
| Based on Mean | $266,919,020 | $2,581,488 |
| Based on Median | $145,719,370 | $801,000 |

[a] Estimates exclude license fees.

[b] Estimates consist of aggregate use and preservation values.

[c] Source: Alberta Forestry, Lands and Wildlife (1988).

[d] d.f. is discount factor.

total benefits by at least 25%.

**E. Summary and Implications**

The assertion was made in the introduction to this research (see chapter I) that the contribution of nonmarket natural resource commodities (eg., wildlife) to social benefits has often been underrepresented in Benefit-Cost analyses of public projects. In particular, such nonpriced (and/or unpriced) commodities have often been categorised as intangibles and excluded from quantitative analyses. In recent years, progress has been made towards developing techniques for estimating the value of so-called intangibles. However, such methods have not completely solved the valuation problem because they have focused only on values derived from actual use of the given resource. In view of the perceived gap in empirical knowledge, this study set out to provide an estimate of the total economic value of wildlife resources in Alberta. This attempt represents an extension of previous research efforts in Alberta in that it incorporates nonuse values into the valuation process.

The argument was made above that reasons for lack of progress in estimating nonuse values include lack of a consistent and realistic taxonomy, and the absence of a plausible theoretical base. This study utilized a contingent valuation design, developed from a simplified taxonomy of economic value, to obtain the empirical estimates. The methodology was based on a neoclassical consumer choice framework. The results indicate that the total economic benefits of big game species alone are in excess of $25m annually. In general, the study results corroborate those of similar studies carried out in Canada and the United States which conclude that substantial benefits accrue from wildlife resources. More importantly, they indicate that nonuse benefits account for a fairly significant portion of the total economic value of wildlife resources.

For a number of reasons, the figures reported here must be regarded as lower bound estimates when used for public policy analysis. First, only the value of big game resources (in general) and grizzly bear (in particular) were considered due to study limitations. Therefore

the economic value for all types of wildlife (eg., waterfowl, upland bird game, etc.) will definitely be greater. Second, using a discount rate of, say, 5% in perpetuity presumes that the value of nonconsumptive activities will remain unchanged in the future and that the level of participation will be constant. This is, of course, a simplified view of the future. As certain types of wildlife or recreational opportunities decline, their relative values will definitely increase. Finally, nonuse benefits reported in the study accrue only to the hunter population. Therefore the inclusion of nonuse values for the general population will result in even greater benefits.

While there may be uncertainty regarding the accuracy of the aggregate benefit estimates as a result of aggregation and other problems, the point needs to be made that the individual willingness-to-pay estimates obtained in this study are of a reasonably high quality. This fact is attested to by the relatively small confidence intervals (see Table IV.4) and by the results of the various tests built into the research design to check the consistency and accuracy of the data. These tests concluded, *inter alia*, that there was no significant misperception of the hypothetical commodity and that the estimates were consistent with theory (see test results in chapter II).

This study has attempted to make a contribution to the measurement of nonuse values by employing an approach which seeks to forge a link between theory and methodology. However, research in this area is still in its infancy. An area for future research is the actual process by which consumers make decisions. In particular, we need to explore the role of psychological and other noneconomic factors in value formation. This calls for an interdisciplinary approach involving researchers from the sociology and psychology professions. In undertaking such new research endeavors, we need to explore the area of experimental economics. A series of laboratory or small-scale field experiments could be a relatively inexpensive method of investigating some of the issues raised above. The experimental approach offers the possibility of control and replication which could be used to clarify the findings of nonmarket valuation research. An added advantage is that it could

serve as a means of validating field results.

A problem facing both researchers and resource managers is what constitutes best practice in the estimation of total economic value. Currently, CVM offers the only realistic prospect since market-related approaches do not accommodate nonuse values. Furthermore, as was shown in chapter III, CVM is capable of providing values for future supply levels of an existing or potential commodity, whereas market-related approaches are restricted to existing commodities and supply levels. However, even within CVM, there are competing approaches. In this study, a "piecewise" approach was employed. That is, use and nonuse values were measured separately and then summed. Others (eg., Walsh et al. 1985, Walsh et al. 1984 and Boyle and Bishop 1987) advocate a "decomposition" approach. That is, respondents are first asked for an estimate of their total economic value, and then are requested to distribute it among the various component values. However, given the current state of knowledge in nonmarket value estimation, it is not clear to what extent respondents have sufficiently clear perceptions of their personal valuations to accurately distribute total value among various components. An important factor, in this regard, is the extent to which the good in question is amenable to valuation. The approach adopted here simplifies the valuation task by requiring respondents to provide two values: a use value (if applicable) and a nonuse (preservation) value[51]. Additional research is required to determine which approach works best. Furthermore, research is required to devise tests by which the validity of nonuse values could be ascertained.

[51] Greenley et al. (1981) have used a somewhat similar approach. The difference between that study and the present one is that here, each respondent is presented with two different scenarios for use and nonuse. Thus, the risk of overstating total WTP may be minimized.

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## V. Summary and Conclusions

The purpose of this research was to contribute to the development of contingent valuation methodology (CVM) by exploring ways of incorporating uncertainty and nonuse elements into nonmarket value measures. In this concluding chapter, the major findings of the research are summarized and the implications discussed. Finally, the directions for future research are addressed.

The main sources of doubt about the efficacy of the CVM have been the hypothetical nature of the approach and the "public goods" characteristics of nonmarket commodities, which are presumed to cause various types of error or 'bias'. In chapter II of this research, the issue of bias in contingent valuation surveys was addressed. The validity and usefulness of current practice in testing strategic bias (Brookshire et al. 1976) and selection bias (Desvousges et al. 1987; Smith and Desvousges 1987) were critically examined. Tests of framing effects and the validity of CV responses were proposed and implemented.

A popular data handling procedure in CV surveys is to delete zero bids and outliers using *ad hoc* means (eg., predetermined cut-off points) or by examining the effects of deleting individual observations on regression parameters (see, for example, Belsley et al. 1986). The implicit assumption underlying such procedures is that zero or very high bids represent biased or strategic bidding. In a comparison of the socioeconomic characteristics of those whose CV bids might be considered as outliers, high levels of hunting expenditures were observed whereas no significant differences in income were found between this group and other positive bidders. Furthermore, no significant socioeconomic differences were found between zero bidders and positive bidders. It was thus concluded that the current procedures could be arbitrary since some outliers and zero bids could in fact be genuine. Zero bids, for example, could be an indication of the fact that the individual had fully extracted his or her consumer's surplus.

Heckman (1979) has proposed a procedure which treats the case of selection bias as an "omitted variable" problem. By choosing a given selection rule, the researcher truncates the

data and ends up with with an incomplete sample. Heckman suggests estimating a new variable, $\lambda_j$, utilizing information on the omitted variables. The problem of selection bias is accounted for by including $\lambda_j$ as a regressor in the OLS estimation of the incomplete sample. It was noted that the Heckman procedure, as recently applied in CVM, is not valid because it merely tests for selection bias caused by the researcher by following a given selection rule. It was shown that a more plausible approach would be to utilize information on refusals or, better still, nonrespondents.

The results of the test of framing effects indicated that there was no significant misperception of the hypothetical commodity since two different representations of the same good resulted in nearly identical CV estimates. However, it was found that differences in the willingness-to-pay question format may have affected the precision of those estimates. The above findings are consistent with those of Boyle (1989). In general, they point to the need to ensure that CV respondents have a sufficiently clear understanding of the contingent market scenario and the valuation task at hand.

Previous attempts at establishing the validity of CVM have relied on the comparison of CV estimates with those of other methods (eg., Brookshire et al. 1982; Desvousges et al. 1983 and Sellar et al. 1985). The validity of such "comparison tests" was called into question since the true underlying value of CV estimates cannot be ascertained from comparisons with other methods. It was advocated that a more plausible approach to testing the validity of CV value measures would be to derive testable hypotheses based on economic theory. One such test proposed was based on the principle of nonsatiation. The test results concluded that the null hypothesis could not be rejected, implying that the reported values satisfied the principle of nonsatiation.

The foregoing results pose several important implications for CVM method and practice. They demonstrate that data of reasonable quality can be generated from a carefully designed CV procedure given that Cummings et al's 1986 Reference Operating Conditions (ROC's) prevail. It was argued in chapter II that satisfaction of the ROC's is a necessary but

not sufficient condition for ensuring the reliability of CV responses. In general, the test results suggest that the hypothetical nature of the CVM is not necessarily an unsurmountable obstacle in attempting to obtain reliable estimates for nonmarket commodities. Nevertheless, there is a need to routinely test the reliability of CV responses in order to enhance confidence in the approach. It is recommended that tests utilizing split samples, such as was applied in this study, be routinely included in CV surveys as a means of checking the accuracy of the responses. The usual procedure of deleting zero and large bids to produce a "reasonable" set of observations must not be followed arbitrarily. Methods such as Belsley et al. diagnostics must be used in conjunction with other data screening approaches - viz., analysis of expenditures and responses to follow-up questions. If survey results are to be extrapolated to the general population, as was the case in this study, they must include all bids except those judged to be protest or endowment bids[52].

Chapter III dealt with the issue of uncertainty. Two different CV methodologies were devised to elicit values under demand and supply uncertainty. Further, in keeping with the recommendations of chapter II, tests were devised to ascertain whether respondents behaved according to the postulates of expected utility (EU) theory. Only a small proportion of the sample was found to have violated the axioms derived from the theory. Thus, it was concluded that the estimated bids were consistent with the predictions of the theory. The discussion on demand uncertainty focused on the merits of the fair-bet point *vis-a-vis* option price. Empirical problems arising from attempts to estimate the fair-bet point in the study were noted. It was concluded that option price was a more practicable and reliable measure of benefits given demand uncertainty. The usefulness of the fair-bet point was questioned in view of serious theoretical and empirical problems. On supply uncertainty, it was shown that option price estimates are significantly affected by the level of supply uncertainty, individuals' demand probabilities and their time horizon for use. Some optimism was expressed for the use

[52] A protest bid is a zero or low bid made in protest against the valuation exercise or against government policy. An endowment bid is an extraordinarily high bid made to empathize with the commodity or made for a cause unrelated to the CV excercise.

of CV methodology in addressing the uncertainty problem. However, it was noted that further research would be required to improve the performance of existing models.

In modeling supply uncertainty, the study chose to use availability of a hunting license as a proxy for the source of the uncertainty. It has been suggested that supply uncertainty could be modeled by using the physical availability of a given species. However, such an approach could be problematic in view of information from this study which indicates that catch is not a prime motivating factor in hunting. Factors such as outdoor enjoyment, exercise and companionship appear to be equally significant in the decision to go hunting. The study attempted to simplify the analysis by separately examining demand and supply uncertainty in 'controlled' situations. However, it would appear that to further advance CV methodology in this area, efforts must be made to integrate both supply and demand uncertainty where this is justified by the particular problem at hand. Presently, demand-side option price models are so specified as to elicit maximum willingness-to-pay on the assumption that the commodity will be supplied on payment of the specified contingent fee. This presumes that supply uncertainty is nonexistent. Such an assumption may be entirely plausible for certain practical situations. However, as Freeman (1985) points out, there may be many cases in which a project or program may not guarantee the elimination of the uncertainty.

A case in point is the second scenario of chapter III (supply uncertainty) in which there is actually a nonzero (albeit small) probability of not being supplied with a license even on complying with the terms of the proposed wildlife management program. All the program does is enhance one's chances of gaining access to the given recreational area. It is clearly stated in the survey instrument that the chances of obtaining a hunting license are not 100%[53]. Recent theoretical developments indicate that, in this case, option price will depend on the nature of the supply uncertainty as reflected by the probability of supply with and without

[53] Respondents could also choose to go grizzly bear hunting elsewhere. However, in reality, availabilty of substitutes in this case is limited since the hypothetical area covers a large portion of prime grizzly bear habitat in the province.

the program, the degree of demand uncertainty, and other factors which impinge on demand uncertainty (eg., see Freeman 1985, Plummer and Hartman 1986).

The final empirical study, chapter IV, addressed the complex issue of total economic value. A methodology, based on this taxonomy and a utility-theoretic model, was used to obtain estimates of total economic value. The empirical results indicated that benefits derived from wildlife resources in Alberta are substantial. In addition, nonuse values were found to be a significant proportion of such benefits. It was thus concluded that the omission of nonuse values in public policy analysis could result in the underestimation of gross benefits.

In order to enhance the current state-of-the-art in CV methodology, a great deal of effort needs to be expended on the key issues of "reliability" and "validity" of CV value estimates. Reliability can be defined as the extent to which the variance of reported WTP is due to random error or "pure noise". A measure of reliability is the standard error of the mean WTP. Validity is the degree to which the CV instrument actually measures willingness-to-pay. A measure of validity is the extent to which reported WTP estimates accord with the predictions of economic theory.

Some issues for further research, arising from this study, are the following:

1. A need for a better understanding of the process by which individuals make their valuations. This could lead to the development of more realistic models.
2. A search for better approaches to modeling uncertainty.
3. A search for improved methods of structuring CV questions in order to effectively elicit option price, fair-bet value, preservation value, etc.
4. A need for ways and means of ascertaining whether measured values correspond to perceived values.
5. The development of more and superior forms of bias testing, including tests derived from economic theory.

Experimental economics or laboratory-type experiments offer promising prospects for exploring many of the above issues. Although the utility of this approach has been questioned

(eg., see Mitchell and Carson 1986), it appears to offer a cost-effective and practical means of studying individual behavior. Experimental methods (eg., Vickery and Smith-type auctions) could allow key decision variables to be manipulated and subsequent outcomes studied. In doing so, valuable information could be gleaned which might then be utilized in planning field surveys. However, in order to make meaningful progress in this relatively new area of research, the active collaboration of researchers in other social science disciplines (eg., sociology and psychology) must be sought.

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## Appendix A

**Table A1 Results of Regression Diagnostics (Chapter II)**

| ID | WTP | DFBETAS[a] AGE | EDUC | INC | CONST. | DFFITS[b] |
|---|---|---|---|---|---|---|
| 98 | 5000 | 0.3711 | 0.3552 | 2.7887 | -0.9465 | 2.9729 |
| 140 | 500 | 0.0271 | 0.1089 | -0.6026 | 0.0294 | -0.6085 |
| 199 | 1000 | 0.0998 | 0.1114 | 0.0077 | -0.1195 | 0.1693 |
| 374 | 3500 | 0.0311 | 0.1698 | 1.7893 | -0.4310 | 1.8759 |
| 380 | 1000 | 0.1982 | 0.0378 | 0.0313 | -0.1539 | 0.2181 |
| 501 | 1200 | 0.2356 | -0.2797 | -0.0660 | -0.0404 | 0.4142 |
| 578 | 2000 | -0.2694 | -0.0531 | -0.0337 | 0.2911 | 0.3534 |
| 609 | 900 | -0.0376 | -0.1063 | 0.1383 | 0.0746 | 0.1769 |
| 642 | 1000 | 0.0411 | 0.0809 | 0.1576 | -0.0602 | 0.1856 |
| 675 | 300 | 0.0074 | 0.0311 | -0.6101 | -0.0880 | -0.6201 |
| 741 | 1500 | -0.0020 | -0.0108 | 0.1604 | 0.0068 | 0.2114 |
| 762 | 2000 | -0.0282 | -0.0548 | 0.4671 | -0.0048 | 0.5020 |
| 766 | 1200 | 0.0671 | 0.1618 | -0.0530 | -0.1037 | 0.2096 |
| 788 | 1000 | 0.1585 | 0.0369 | 0.0281 | -0.1232 | 0.1833 |
| 849 | 1500 | 0.0593 | 0.1041 | 0.2856 | -0.1396 | 0.3445 |
| 888 | 1000 | 0.0982 | 0.1375 | -0.0666 | -0.1145 | 0.1958 |

[a] Critical value (size adjusted) for DFBETAS is $2 / \sqrt{n} = 0.0784$, where $N = 651$.
[b] Critical value (size adjusted) for DFFITS is $2\sqrt{(K/N)} = 0.1568$, where $N = 651$ and $K = 4$.

## Appendix B

**Figure B1 Bid Distributions (Use Value)**

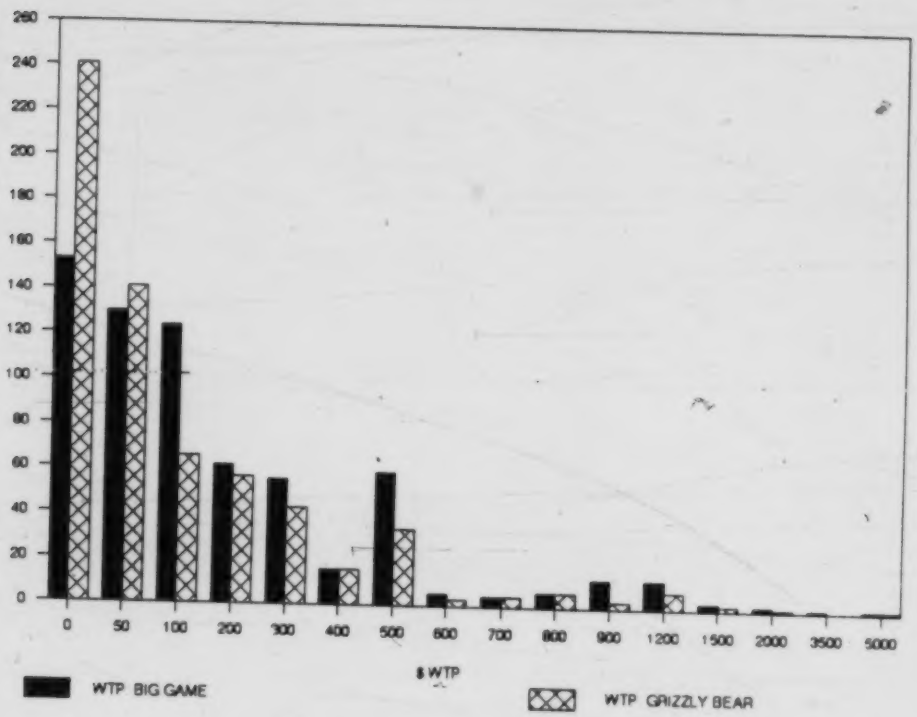
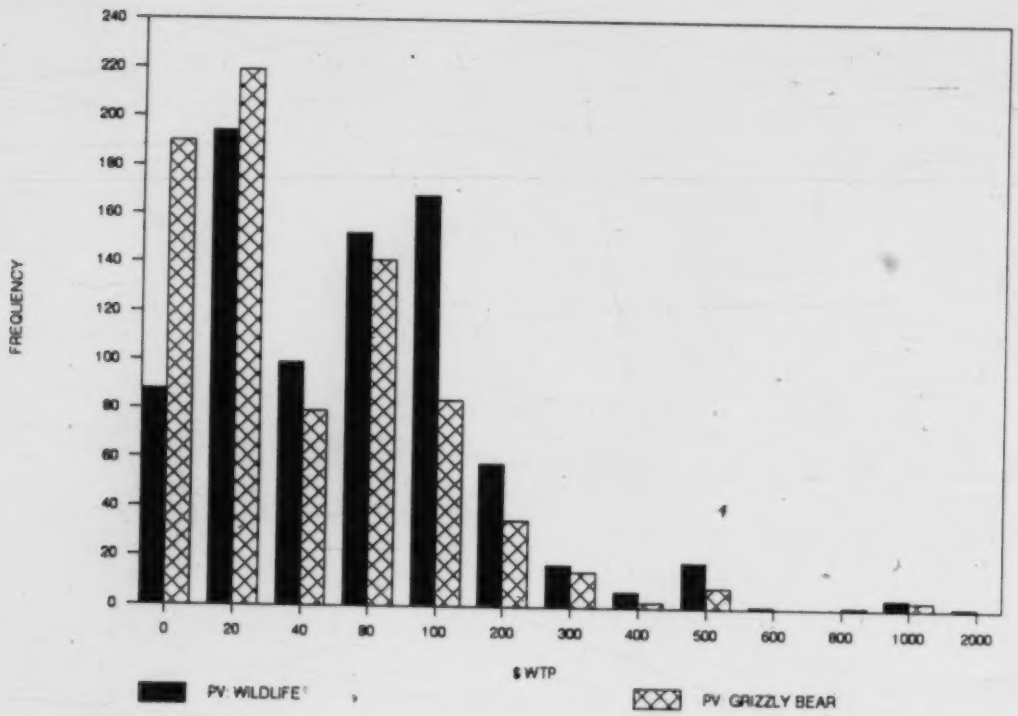


**Figure B2 Bid Distributions (Preservation Value)**



## Appendix C

# Survey Instruments

**Fish and Wildlife Division**
**Alberta Forestry, Lands and Wildlife**
**Edmonton, Alberta T5K 2G6**

**Department of Rural Economy**
**University of Alberta**
**Edmonton, Alberta T6G 2H1**

Dear Sir/Madam,

As you know, wildlife resources play a very important role in the social and economic development of the province of Alberta. However, in order to protect and manage these resources in a manner which provides the most benefit to all Albertans, there is a need to collect information to facilitate this process.

This survey is being conducted by the Department of Rural Economy (University of Alberta), in cooperation with Fish and Wildlife Division (Alberta Forestry, Lands and Wildlife). Our objective is to determine the extent and value of recreational activities related to wildlife.

We request your cooperation in completing, and returning, the enclosed questionnaire. To ensure that your individual responses are held in strict confidence, they will be combined with those of other respondents. It is not necessary to reveal your identity.

We hope you share our objective of making wildlife management programs more responsive to the needs of present and future generations. Please take a few minutes to fill out the questionnaire, and tell us your concerns, if any, about Alberta's wildlife resources. Your anticipated cooperation and assistance are greatly appreciated.

Sincerely,

Les Cooke, Assistant Deputy Minister
Forestry, Lands and Wildlife

Bill Phillips, Chairman
Rural Economy, University of Alberta

**A Research Project Co-funded by the Alberta Recreation, Parks and Wildlife Foundation**

**Fish and Wildlife Division**
**Alberta Forestry, Lands and Wildlife**
**Edmonton, Alberta T5K 2G6**

**Department of Rural Economy**
**University of Alberta**
**Edmonton, Alberta T6G 2H1**

Dear Sir/Madam,

Several weeks ago, you were mailed a copy of the enclosed questionnaire and covering letter. If you have completed and returned the original questionnaire, please disregard this note. If for some reason you have not responded to our survey, we would be grateful if you would take a few minutes and complete the enclosed questionnaire. We are anxious to receive as many returns as possible in order to ensure the success of this project.

Thanking you in advance.

Sincerely,

Les Cooke, Assistant Deputy Minister
Forestry, Lands and Wildlife

Bill Phillips, Chairman
Rural Economy, University of Alberta

**A Research Project Co-funded by the Alberta Recreation, Parks and Wildlife Foundation**

University of Alberta
Department of Rural Economy
Edmonton, T6H 2H1

CONFIDENTIAL

## ALBERTA WILDLIFE RECREATIONAL STUDY

The purpose of this study is to determine the extent and value of recreational activities related to wildlife in Alberta.

### A. QUESTIONS ABOUT HUNTING WILDLIFE

FOR OFFICE USE ONLY

1. Which of the following best describes your attitude towards wildlife, in general? (check the appropriate box).

   ☐ I value wildlife very highly
   ☐ I value wildlife highly
   ☐ I value wildlife moderately
   ☐ I have a low value for wildlife
   ☐ I have no value for wildlife

2. How many years hunting experience have you had?

   Big Game ___ years
   Bird Game ___ years

3. What are the main reasons that you go hunting? Rank the following in order of importance, eg., 1st, 2nd, 3rd choices, etc.

   ___ For meat
   ___ For trophy
   ___ For outdoor enjoyment
   ___ For companionship
   ___ For exercise
   ___ Other (please specify)_____

4. Have you ever hunted in Alberta before the 1987/88 season?

   ☐ Yes If "Yes", how many years? ___
   ☐ No

5. Please respond to the questions below by checking the appropriate box.

   a. In the 1987/88 season, did you hunt for sport at least once?

      ☐ Yes (PLEASE PROCEED TO SECTION B)
      ☐ No (GO TO THE NEXT QUESTION)

   b. Would you like to hunt grizzly bear sometime in the future?

      ☐ Yes (PLEASE PROCEED TO SECTION C)
      ☐ No (GO TO SECTION D)

CONTINUED ON REVERSE →

## B. GENERAL INFORMATION ON HUNTING TRIPS

This section is only to be completed if you hunted for sport in the 1987/88 season.

1. Please complete the following information for each Alberta hunting trip undertaken. Consider 1 FULL day of hunting to be 4 or more hours spent in the activity.

   Also, rate each Alberta hunting trip by providing a value on a scale of 1 to 5 for each of two categories below. The rating scale for each category is :

   a. Hunting quality (includes sightings or observations of animals, access, remoteness): 1 = Very poor quality; 2 = Poor quality; 3 = Moderate quality; 4 = High quality; 5 = Extremely high quality.

   b. Crowding (were there too many people at the site?):
   1 = Extremely high crowding; 2 = High crowding; 3 = Moderate crowding; 4 = Low crowding 5 = Extremely low crowding.

| Trip No. | Area(s) hunted: WMU, nearest town or landmark | Days Hunted | Miles to Area | No. in Hunting Party | Type of Game Hunted | Game bagged by yourself only (type & number) | HUNTING QUALITY (Very Poor … Very Good) | CROWDING (Crowded … Not Crowded) |
|---|---|---|---|---|---|---|---|---|
| Eg. | Vermilion | 3 | 100 | 2 | Deer & Grouse | 0 deer 3 grouse | 1 2 3 [4] 5 | 1 [2] 3 4 5 |
| 1. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 2. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 3. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 4. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 5. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 6. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 7. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 8. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 9. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 10. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |

CONTINUED ON NEXT PAGE→

2. Please estimate, as best as you can, the amount of money you personally spent for hunting purposes in Alberta during the 1987/88 season. Indicate the amount beside the appropriate category.

ITEM

Travel cost $_____
(includes gasoline, oil, air fare, etc.) ____

Lodging $_____
(includes hotels, motels, camping fees, etc.) ____

Food $_____
(includes restaurant meals, purchased food, beverages, etc.) ____

Guides $_____
(includes guiding and outfitting fees, etc.) ____

Ammunition $_____ ____

Rentals $_____ ____

Other (please specify below) $_____ ____

_____ ____

3. How much would you have been willing to pay (above what you spent on travel and other expenses) to hunt big game in Alberta in 1987/88? (Please circle the appropriate dollar value).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____ ____

4. Now, we would like to ask you specifically about grizzly bear hunting:
How much would you have been willing to pay (above what you spent on travel and other expenses) to hunt grizzly bears in Alberta in 1987/88? (Please circle the appropriate dollar value).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____ ____

PLEASE PROCEED TO SECTION C →

C. QUESTIONS ABOUT THE RECREATIONAL VALUE OF GRIZZLY BEAR HUNTING

* This section of the questionnaire is part of an experiment designed to provide an indication of the recreational value of grizzly bear hunting. The details which follow relate to a hypothetical situation to give you a reference point for your answers, and DO NOT reflect any specific management plans on behalf of the Government.

Suppose a public trust fund were set up to pay for a 5-year management program to increase the grizzly bear population in the area shown on the attached map, to enable you to hunt there. Such a program would consist of restricting access to the area, improving habitat by selective cutting, burning, seeding, and planting berry-producing plants. It is expected that this program would increase the grizzly bear population by as much as 20%.

To participate in this program, you would have to make annual payments into the fund for the next five years. At the end of that period, you will be guaranteed access every year, and continuing into the future.

Given this background information, please answer the following questions as accurately as you can:

1. Which of the following best describes the chances of you wanting to hunt grizzly bear in Alberta after 5 years? (Please check one).

   ☐ I will definitely want to hunt grizzly bear
   ☐ There's an even chance I might want to hunt grizzly bear
   ☐ There's a small chance I might want to hunt grizzly bear
   ☐ There's no chance I might want to hunt grizzly bear

2. What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund each year, if there there will be NO REFUND of your money whether or not you decide to go hunting after 5 years? $_____

3. What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund each year, if there will be a FULL REFUND of your money should you decide not to go hunting after 5 years? $_____

4. What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund each year, if HALF of the total you contribute will be refunded to you should you decide not to go hunting after 5 years? $_____

5. What is the MAXIMUM amount of money you would be willing to contribute to the grizzly bear fund each year, if there will be a FULL REFUND of your money should you decide to go hunting after 5 years? $_____

PLEASE PROCEED TO SECTION D →

## D. QUESTIONS ABOUT THE USE OF WILDLIFE FOR NON-HUNTING PURPOSES

1. During 1987, did you take any trips for which the **primary** purpose was to watch, feed, photograph or study wildlife?

☐ Yes ☐ No (Go to Question 5).

2. Which of the following activities did you participate in? (check one or more of these categories).

☐ Watching and/or feeding wildlife (in the natural state)
☐ Photographing wildlife (in the natural state)
☐ Studying and identifying wildlife (in the natural state)

3. Approximately how many days in 1987 did you spend in each activity? (Note: 1 FULL day is 4 or more hours spent in the actvity. For those who answered SECTION C, don't include hunting time.)

Watching and/or feeding ____ days.
Photographing ____ days.
Studying and identifying ____ days.

4. Which of the following types of wildlife did you watch, feed, photograph or study? (check one or more of these categories).

___ Ungulates (Deer, Elk, Moose, Sheep, etc.)
___ Large Carnivores (Bears, Wolves, etc.)
___ Upland Bird (Grouse, Ptarmigan, etc.)
___ Waterfowl (Ducks, Geese, etc.)
___ Other Birds (Songbirds, Eagles, etc.)
___ Small Mammals (Rabbits, Squirrels, etc.)

5. The following questions are intended to give an indication of how you value the preservation of wildlife in Alberta. Suppose a public trust fund were set up to preserve wildlife in Alberta.

a. What is the MAXIMUM amount of money you would be willing to donate annually to the fund for the preservation of wildlife? (Please circle the appropriate dollar value).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 |
| 100 | 105 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 170 | 180 | 190 |
| 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____

8. What is the MAXIMUM amount of money you would be willing to donate annually to the fund, if it were specifically for the preservation of grizzly bear? (Please circle the appropriate dollar value).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 |
| 100 | 105 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 170 | 180 | 190 |
| 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____

**PLEASE PROCEED TO SECTION E →**

## E. PERSONAL INFORMATION

We know that hunters with different characteristics and backgrounds have different wildlife recreational values. For that reason, we would appreciate your answering the following, more personal questions. Your answers will be held confidential, and you personally will not be identified in the results of the study.

1. In which town or city do you live? _____ ___

2. What is your age? _____ years. ___

3. Sex (please check one). _

☐ Male
☐ Female

4. What is your highest year of schooling completed? Please circle one.

Grade/High School 0 1 2 3 4 5 6 7 8 9 10 11 12 ___

Post Secondary Education:
University/College/Technical
or Trade School (years) 1 2 3 4 5 6 7 8 9 10 11 12 or more ___

5. Including yourself, how many of your immediate family are living at your residence? Please circle. _

1 2 3 4 5 6 7 8 9 or more

6. To the best of your knowledge, what was the total amount of money earned (before taxes) by you and your family in 1987? Please estimate and check the appropriate category: ___

| | |
|---|---|
| ___ $4,999 or less | ___ $30,000 - 34,999 |
| ___ $5,000 - 9,999 | ___ $35,000 - 39,999 |
| ___ $10,000 - 14,999 | ___ $40,000 - 49,999 |
| ___ $15,000 - 19,999 | ___ $50,000 - 59,999 |
| ___ $20,000 - 24,999 | ___ $60,000 - 69,999 |
| ___ $25,000 - 29,999 | ___ $70,000 or over |

7. If you have any additional comments on wildlife management in Alberta, please provide them on the back of the attached map.

Thank you for co-operation. Please return your questionnaire today using the stamped, self-addressed envelope that has been provided.

(FORM A1)

CONFIDENTIAL

University of Alberta
Department of Rural Economy
Edmonton, T6H 2H1

## ALBERTA WILDLIFE RECREATIONAL STUDY

The purpose of this study is to determine the extent and value of recreational activities related to wildlife in Alberta.

### A. QUESTIONS ABOUT HUNTING WILDLIFE

FOR OFFICE USE ONLY

1. Which of the following best describes your attitude towards wildlife, in general? (check the appropriate box).

   ☐ I value wildlife very highly
   ☐ I value wildlife highly
   ☐ I value wildlife moderately
   ☐ I have a low value for wildlife
   ☐ I have no value for wildlife

2. How many years hunting experience have you had?

   Big Game ___ years
   Bird Game ___ years

3. What are the main reasons that you go hunting? Rank the following in order of importance, eg., 1st, 2nd, 3rd choices, etc.

   ___ For meat
   ___ For trophy
   ___ For outdoor enjoyment
   ___ For companionship
   ___ For exercise
   ___ Other (please specify)_____

4. Have you ever hunted in Alberta before the 1987/88 season?

   ☐ Yes If "Yes", how many years? ___
   ☐ No

5. Please respond to the questions below by checking the appropriate box.

   a. In the 1987/88 season, did you hunt for sport at least once?

      ☐ Yes (PLEASE PROCEED TO SECTION B)
      ☐ No (GO TO THE NEXT QUESTION)

   b. Would you like to hunt grizzly bear sometime in the future?

      ☐ Yes (PLEASE PROCEED TO SECTION C)
      ☐ No (GO TO SECTION D)

CONTINUED ON REVERSE →

## B. GENERAL INFORMATION ON HUNTING TRIPS

This section is only to be completed if you hunted for sport in the 1987/88 season.

1. Please complete the following information for each Alberta hunting trip undertaken. Consider 1 FULL day of hunting to be 4 or more hours spent in the activity.

   Also, rate each Alberta hunting trip by providing a value on a scale of 1 to 5 for each of two categories below. The rating scale for each category is :

   a. Hunting quality (includes sightings or observations of animals, access, remoteness): 1 = Very poor quality; 2 = Poor quality; 3 = Moderate quality; 4 = High quality; 5 = Extremely high quality.

   b. Crowding (were there too many people at the site?):
   1 = Extremely high crowding; 2 = High crowding; 3 = Moderate crowding; 4 = Low crowding 5 = Extremely low crowding.

| Trip No. | Area(s) hunted: WMU, nearest town or landmark | Days Hunted | Miles to Area | No. in Hunting Party | Type of Game Hunted | Game bagged by yourself only (type & number) | HUNTING QUALITY (Very Poor … Very Good) | CROWDING (Crowded … Not Crowded) |
|---|---|---|---|---|---|---|---|---|
| Eg. | Vermilion | 3 | 100 | 2 | Deer & Grouse | 0 deer 3 grouse | 1 2 3 [4] 5 | 1 [2] 3 4 5 |
| 1. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 2. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 3. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 4. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 5. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 6. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 7. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 8. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 9. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 10. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |

CONTINUED ON NEXT PAGE→

2. Please estimate, as best as you can, the amount of money you personally spent for hunting purposes in Alberta during the 1987/88 season. Indicate the amount beside the appropriate category.

ITEM

Travel cost $_____
(includes gasoline, oil, air fare, etc.) ____

Lodging $_____
(includes hotels, motels, camping fees, etc.) ____

Food $_____
(includes restaurant meals, purchased food, beverages, etc.) ____

Guides $_____
(includes guiding and outfitting fees, etc.) ____

Ammunition $_____ ____

Rentals $_____ ____

Other (please specify below) $_____ ____

_____ ____

____

____

3. How much would you have been willing to pay (above what you spent on travel and other expenses) to hunt big game in Alberta in 1987/88? (Please circle the appropriate dollar value).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____ ____

4. Now, we would like to ask you specifically about grizzly bear hunting:
How much would you have been willing to pay (above what you spent on travel and other expenses) to hunt grizzly bears in Alberta in 1987/88? (Please circle the appropriate dollar value).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____ ____

PLEASE PROCEED TO SECTION C →

## C. QUESTIONS ABOUT THE RECREATIONAL VALUE OF GRIZZLY BEAR HUNTING

This section of the questionnaire is part of an experiment designed to provide an indication of the recreational value of grizzly bear hunting. The details which follow relate to a hypothetical situation to give you a reference point for your answers, and DO NOT reflect any specific management plans on behalf of the Government.

Suppose a public trust fund were set up to pay for a 5-year management program to increase the grizzly bear population in the area shown on the attached map, to enable you to hunt there. Such a program would consist of restricting access to the area, improving habitat by selective cutting, burning, seeding, and planting berry-producing plants. It is expected that this program would increase the grizzly bear population by as much as 20%.

To participate in this program, you would have to make annual payments into the fund for the next five years. At the end of that period, you will be guaranteed access every year, and continuing into the future.

Given this background information, please answer the following questions as accurately as you can:

1. How many more years do you expect to hunt grizzly bear? ___ years.

2. How much would you be willing to pay annually to the grizzly bear fund to reserve your option of hunting grizzly bear in 5 years?

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____

3. Which of the following best describes the chances of you wanting to hunt grizzly bear after 5 years? (Please check one).

- ☐ I will definitely want to hunt grizzly bear
- ☐ There's an even chance I might want to hunt grizzly bear
- ☐ There's a small chance I might want to hunt grizzly bear
- ☐ There's no chance I might want to hunt grizzly bear

PLEASE PROCEED TO SECTION D →

## D. QUESTIONS ABOUT THE USE OF WILDLIFE FOR NON-HUNTING PURPOSES

1. During 1987, did you take any trips for which the **primary** purpose was to watch, feed, photograph or study wildlife?

   ☐ Yes ☐ No (Go to Question 5).

2. Which of the following activities did you participate in? (check one or more of these categories).

   ☐ Watching and/or feeding wildlife (in the natural state)
   ☐ Photographing wildlife (in the natural state)
   ☐ Studying and identifying wildlife (in the natural state)

3. Approximately how many days in 1987 did you spend in each activity? (Note: 1 FULL day is 4 or more hours spent in the actvity. For those who answered SECTION C, don't include hunting time.)

   Watching and/or feeding ____ days.
   Photographing ____ days.
   Studying and identifying ____ days.

4. Which of the following types of wildlife did you watch, feed, photograph or study? (check one or more of these categories).

   ___ Ungulates (Deer, Elk, Moose, Sheep, etc.)
   ___ Large Carnivores (Bears, Wolves, etc.)
   ___ Upland Bird (Grouse, Ptarmigan, etc.)
   ___ Waterfowl (Ducks, Geese, etc.)
   ___ Other Birds (Songbirds, Eagles, etc.)
   ___ Small Mammals (Rabbits, Squirrels, etc.)

5. The following questions are intended to give an indication of how you value the preservation of wildlife in Alberta. Suppose a public trust fund were set up to preserve wildlife in Alberta.

   a. What is the MAXIMUM amount of money you would be willing to donate annually to the fund for the preservation of wildlife? (Please circle the appropriate dollar value).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 |
| 100 | 105 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 170 | 180 | 190 |
| 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

   If higher or other dollar value, please specify: $_____

   8. What is the MAXIMUM amount of money you would be willing to donate annually to the fund, if it were specifically for the preservation of grizzly bear? (Please circle the appropriate dollar value).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 |
| 100 | 105 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 170 | 180 | 190 |
| 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

   If higher or other dollar value, please specify: $_____

**PLEASE PROCEED TO SECTION E →**

## E. PERSONAL INFORMATION

We know that hunters with different characteristics and backgrounds have different wildlife recreational values. For that reason, we would appreciate your answering the following, more personal questions. Your answers will be held confidential, and you personally will not be identified in the results of the study.

1. In which town or city do you live? _____ ___

2. What is your age? _____ years. ___

3. Sex (please check one). _

☐ Male
☐ Female

4. What is your highest year of schooling completed? Please circle one.

Grade/High School 0 1 2 3 4 5 6 7 8 9 10 11 12 ___

Post Secondary Education:
University/College/Technical
or Trade School (years) 1 2 3 4 5 6 7 8 9 10 11 12 or more ___

5. Including yourself, how many of your immediate family are living at your residence? Please circle. _

1 2 3 4 5 6 7 8 9 or more

6. To the best of your knowledge, what was the total amount of money earned (before taxes) by you and your family in 1987? Please estimate and check the appropriate category: ___

| | |
|---|---|
| ___ $4,999 or less | ___ $30,000 - 34,999 |
| ___ $5,000 - 9,999 | ___ $35,000 - 39,999 |
| ___ $10,000 - 14,999 | ___ $40,000 - 49,999 |
| ___ $15,000 - 19,999 | ___ $50,000 - 59,999 |
| ___ $20,000 - 24,999 | ___ $60,000 - 69,999 |
| ___ $25,000 - 29,999 | ___ $70,000 or over |

7. If you have any additional comments on wildlife management in Alberta, please provide them on the back of the attached map.

Thank you for co-operation. Please return your questionnaire today using the stamped, self-addressed envelope that has been provided.

(FORM A2)

CONFIDENTIAL

University of Alberta
Department of Rural Economy
Edmonton, T6H 2H1

## ALBERTA WILDLIFE RECREATIONAL STUDY

The purpose of this study is to determine the extent and value of recreational activities related to wildlife in Alberta.

### A. QUESTIONS ABOUT HUNTING WILDLIFE

FOR OFFICE USE ONLY

1. Which of the following best describes your attitude towards wildlife, in general? (check the appropriate box).

   ☐ I value wildlife very highly
   ☐ I value wildlife highly
   ☐ I value wildlife moderately
   ☐ I have a low value for wildlife
   ☐ I have no value for wildlife

   _

2. How many years hunting experience have you had?

   Big Game ___ years
   Bird Game ___ years

   _ _
   _ _

3. What are the main reasons that you go hunting? Rank the following in order of importance, eg., 1st, 2nd, 3rd choices, etc.

   ___ For meat
   ___ For trophy
   ___ For outdoor enjoyment
   ___ For companionship
   ___ For exercise
   ___ Other (please specify)_____

   _
   _
   _
   _
   _
   _

4. Have you ever hunted in Alberta before the 1987/88 season?

   ☐ Yes If "Yes", how many years? ___
   ☐ No

   _ _ _

5. Please respond to the questions below by checking the appropriate box.

   a. In the 1987/88 season, did you hunt for sport at least once?

      ☐ Yes (PLEASE PROCEED TO SECTION B)
      ☐ No (GO TO THE NEXT QUESTION)

      _

   b. Would you like to hunt grizzly bear sometime in the future?

      ☐ Yes (PLEASE PROCEED TO SECTION C)
      ☐ No (GO TO SECTION D)

      _

CONTINUED ON REVERSE →

## B. GENERAL INFORMATION ON HUNTING TRIPS

This section is only to be completed if you hunted for sport in the 1987/88 season.

1. Please complete the following information for each Alberta hunting trip undertaken. Consider 1 FULL day of hunting to be 4 or more hours spent in the activity.

   Also, rate each Alberta hunting trip by providing a value on a scale of 1 to 5 for each of two categories below. The rating scale for each category is :

   a. Hunting quality (includes sightings or observations of animals, access, remoteness): 1 = Very poor quality; 2 = Poor quality; 3 = Moderate quality; 4 = High quality; 5 = Extremely high quality.

   b. Crowding (were there too many people at the site?):
   1 = Extremely high crowding; 2 = High crowding; 3 = Moderate crowding; 4 = Low crowding 5 = Extremely low crowding.

| TRIP No. | Area(s) hunted: WMU, nearest town or landmark | Days Hunted | Miles to Area | No. in Hunting Party | Type of Game Hunted | Game bagged by yourself only (type & number) | HUNTING QUALITY (Very Poor … Very Good) | CROWDING (Crowded … Not Crowded) |
|---|---|---|---|---|---|---|---|---|
| Eg. | Vermilion | 3 | 100 | 2 | Deer & Grouse | 0 deer 3 grouse | 1 2 3 [4] 5 | 1 [2] 3 4 5 |
| 1. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 2. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 3. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 4. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 5. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 6. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 7. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 8. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 9. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |
| 10. | | | | | | | 1 2 3 4 5 | 1 2 3 4 5 |

CONTINUED ON NEXT PAGE→

2. Please estimate, as best as you can, the amount of money you personally spent for hunting purposes in Alberta during the 1987/88 season. Indicate the amount beside the appropriate category.

ITEM

Travel cost $_____
(includes gasoline, oil, air fare, etc.) ____

Lodging $_____
(includes hotels, motels, camping fees, etc.) ____

Food $_____
(includes restaurant meals, purchased food, beverages, etc.) ____

Guides $_____
(includes guiding and outfitting fees, etc.) ____

Ammunition $_____ ____

Rentals $_____ ____

Other (please specify below) $_____ ____

_____ ____

3. How much would you have been willing to pay (above what you spent on travel and other expenses) to hunt big game in Alberta in 1987/88? (Please circle the appropriate dollar value).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____ ____

4. Now, we would like to ask you specifically about grizzly bear hunting:
How much would you have been willing to pay (above what you spent on travel and other expenses) to hunt grizzly bears in Alberta in 1987/88? (Please circle the appropriate dollar value).

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 325 | 350 | 375 |
| 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____ ____

PLEASE PROCEED TO SECTION C →

## C. QUESTIONS ABOUT THE RECREATIONAL VALUE OF GRIZZLY BEAR HUNTING

* This section of the questionnaire is part of an experiment designed to provide an indication of the recreational value of grizzly bear hunting. The details which follow relate to a hypothetical situation to give you a reference point for your answers, and DO NOT reflect any specific management plans on behalf of the Government.

The grizzly bear population in Alberta is declining due to deteriorating habitat quality, and increasing contact with humans. This situation has been created by the increasing use of natural wildlife habitat for non-hunting purposes such as agriculture and mining. At present the darkened area on the attached map (see last page) is closed to hunting.

Suppose a public trust fund were set up to pay for a 5-year management program to increase the grizzly bear population in the above area, to allow hunting. It is expected that such a program would increase the grizzly bear population by as much as 20%. This would more than double your chances of getting a grizzly bear hunting license. If you decide to hunt grizzly bear, your chances of shooting a bear could also be more than doubled.

To participate in this program, you would be required to make annual payments into the fund for the next five years to be considered for access at the end of the period, and continuing into the future.

Given this background information, please answer the following questions as accurately as you can:

1. How many more years do you expect to hunt grizzly bear? ___ years. _ _

2. What is the MAXIMUM amount of money you would be willing to pay each year to the grizzly bear fund if there are high chances, 9 in 10, of you getting a grizzly bear license after 5 years? $_____ _ _ _ _

3. What is the MAXIMUM amount of money you would be willing to pay each year to the grizzly bear fund if there are even chances, 5 in 10, of you getting a grizzly bear license after 5 years? $_____ _ _ _ _

4. What is the MAXIMUM amount of money you would be willing to pay each year to the grizzly bear fund if there are low chances, 1 in 10, of you getting a grizzly bear license after 5 years? $_____ _ _ _ _

5. If you obtained a license, what are your chances of wanting to hunt grizzly bear? (please check one).
   - ☐ I will definitely want to hunt grizzly bear
   - ☐ There's an even chance I might want to hunt grizzly bear
   - ☐ There's a small chance I might want to hunt grizzly bear
   - ☐ There's no chance I might want to hunt grizzly bear

PLEASE PROCEED TO SECTION D →

## D. QUESTIONS ABOUT THE USE OF WILDLIFE FOR NON-HUNTING PURPOSES

1. During 1987, did you take any trips for which the **primary** purpose was to watch, feed, photograph or study wildlife?

☐ Yes ☐ No (Go to Question 5).

2. Which of the following activities did you participate in? (check one or more of these categories).

☐ Watching and/or feeding wildlife (in the natural state)
☐ Photographing wildlife (in the natural state)
☐ Studying and identifying wildlife (in the natural state)

3. Approximately how many days in 1987 did you spend in each activity? (Note: 1 FULL day is 4 or more hours spent in the actvity. For those who answered SECTION C, don't include hunting time.)

Watching and/or feeding ____ days.
Photographing ____ days.
Studying and identifying ____ days.

4. Which of the following types of wildlife did you watch, feed, photograph or study? (check one or more of these categories).

___ Ungulates (Deer, Elk, Moose, Sheep, etc.)
___ Large Carnivores (Bears, Wolves, etc.)
___ Upland Bird (Grouse, Ptarmigan, etc.)
___ Waterfowl (Ducks, Geese, etc.)
___ Other Birds (Songbirds, Eagles, etc.)
___ Small Mammals (Rabbits, Squirrels, etc.)

5. The following questions are intended to give an indication of how you value the preservation of wildlife in Alberta. Suppose a public trust fund were set up to preserve wildlife in Alberta.

a. What is the MAXIMUM amount of money you would be willing to donate annually to the fund for the preservation of wildlife? (Please circle the appropriate dollar value).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 |
| 100 | 105 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 170 | 180 | 190 |
| 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____

8. What is the MAXIMUM amount of money you would be willing to donate annually to the fund, if it were specifically for the preservation of grizzly bear? (Please circle the appropriate dollar value).

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 | 70 | 80 | 90 |
| 100 | 105 | 115 | 120 | 125 | 130 | 135 | 140 | 145 | 150 | 155 | 160 | 170 | 180 | 190 |
| 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | 650 | 700 | 750 | 800 | 850 | 900 |

If higher or other dollar value, please specify: $_____

PLEASE PROCEED TO SECTION E →

## E. PERSONAL INFORMATION

We know that hunters with different characteristics and backgrounds have different wildlife recreational values. For that reason, we would appreciate your answering the following, more personal questions. Your answers will be held confidential, and you personally will not be identified in the results of the study.

1. In which town or city do you live? _____ ---

2. What is your age? _____ years. --

3. Sex (please check one). -

☐ Male
☐ Female

4. What is your highest year of schooling completed? Please circle one. --

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade/High School | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Post Secondary Education: University/College/Technical or Trade School (years) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 or more | |

5. Including yourself, how many of your immediate family are living at your residence? Please circle. -

1 2 3 4 5 6 7 8 9 or more

6. To the best of your knowledge, what was the total amount of money earned (before taxes) by you and your family in 1987? Please estimate and check the appropriate category:

| | |
|---|---|
| ___ $4,999 or less | ___ $30,000 - 34,999 |
| ___ $5,000 - 9,999 | ___ $35,000 - 39,999 |
| ___ $10,000 - 14,999 | ___ $40,000 - 49,999 |
| ___ $15,000 - 19,999 | ___ $50,000 - 59,999 |
| ___ $20,000 - 24,999 | ___ $60,000 - 69,999 |
| ___ $25,000 - 29,999 | ___ $70,000 or over |

--

7. If you have any additional comments on wildlife management in Alberta, please provide them on the back of the attached map.

Thank you for co-operation. Please return your questionnaire today using the stamped, self-addressed envelope that has been provided.

(FORM B)

Map of Alberta